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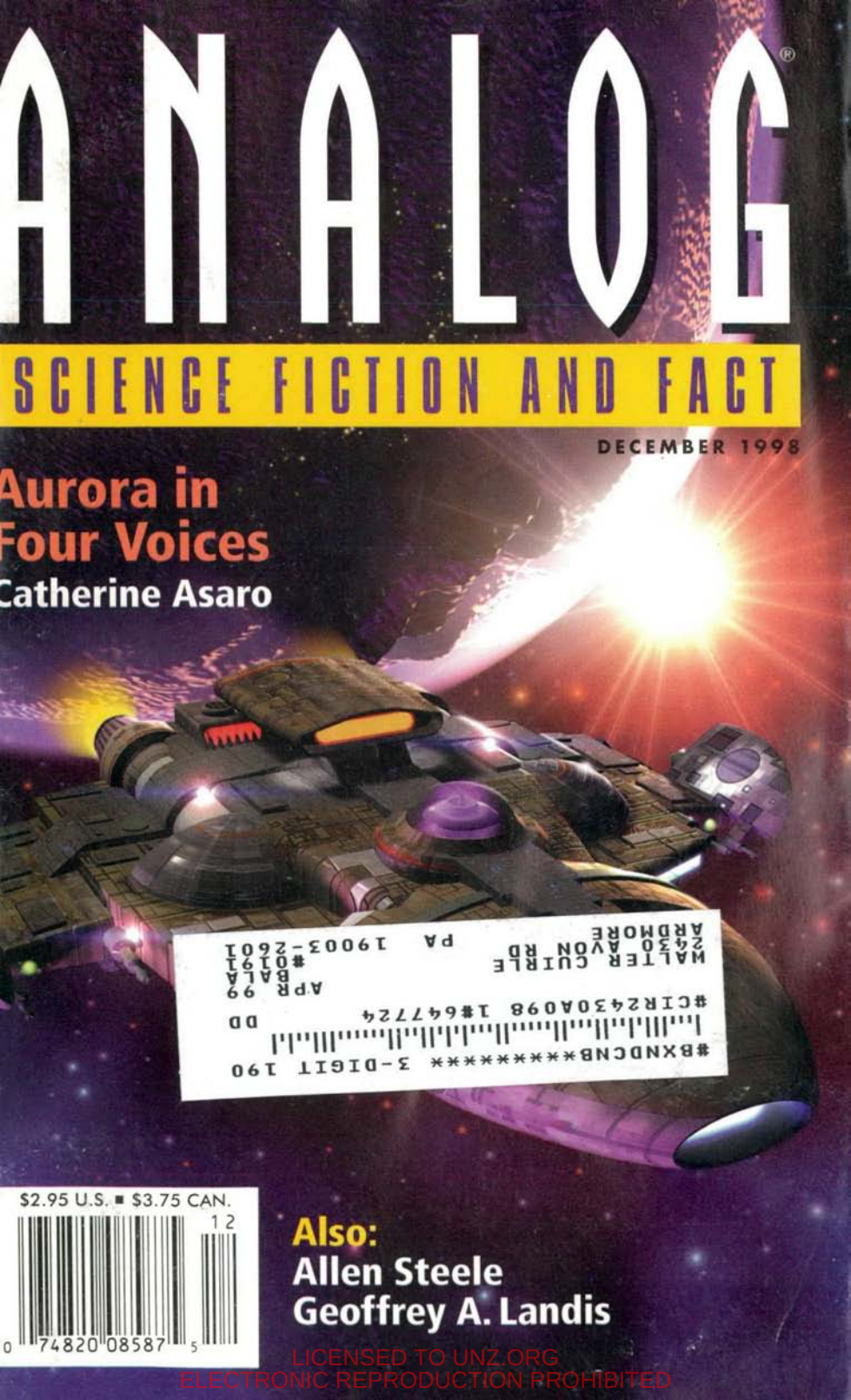

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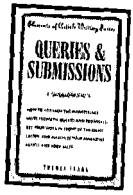

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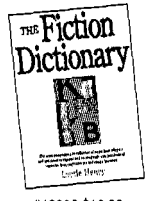

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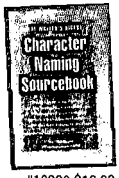

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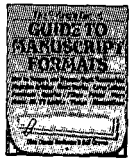

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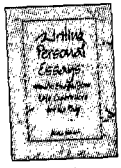

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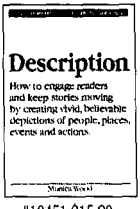
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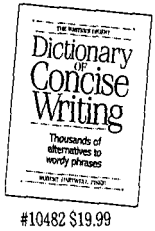

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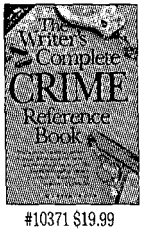

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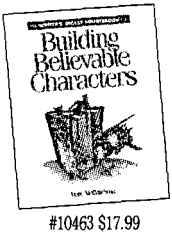

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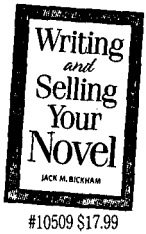

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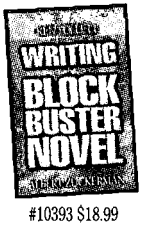

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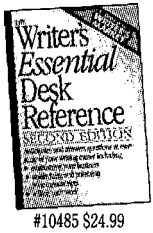

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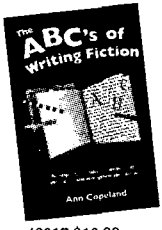

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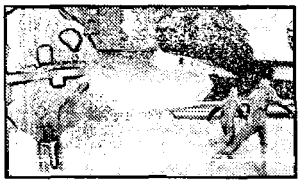

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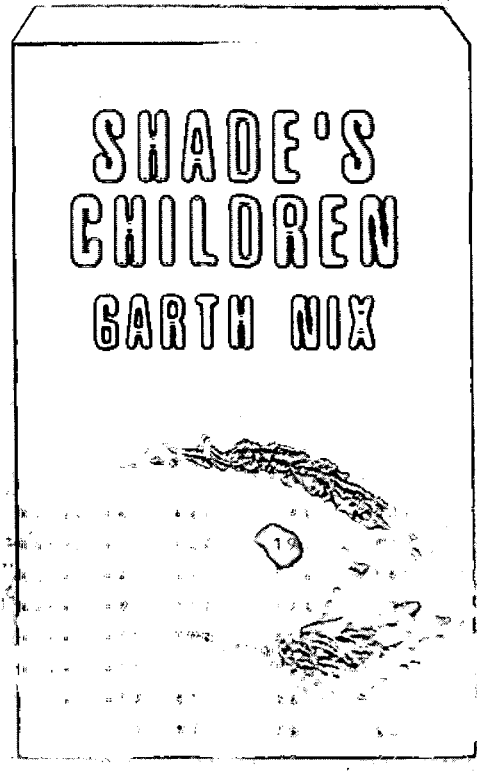

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EDITORIAL Stanley Schmidt

QUALITY CONTROL II: REMINDER AND SPECULATION

When you write essays like this, with the deliberate purpose of provoking people to think about things in ways that they haven't before and often would rather not, you have to expect letters from readers disagreeing with them. Sometimes those letters make points that deserve a response, but the response doesn't necessarily go over any better than the original provocation. Recently, for instance, a reader objected to my suggesting that he look up an editorial that I had written several years earlier in which I had already answered his question at far greater length than I had time to do again. He didn't object to the *content* of that editorial; as far as I know, he didn't read it. What he didn't like was the very idea of citing an old piece of writing as an answer to what he thought of as a new question, as if the editorial's age *per se* somehow invalidated it.

It doesn't, of course. The measure of an idea's value is how well it fits current reality, not when it was put on paper. The issue my esteemed reader had raised was one that resurfaces with little or no change at least every few years. I gave it enough thought when I originally wrote the editorial that periodic rereading shows that it still says exactly what I would say if I were writing it now. So there seemed little point in spending time or page space repeating it when there are so many new fish to fry and I could answer this one simply by pointing to what I'd already said and saying, "*That* is my opinion."

But on reflection, I did think of a real drawback to answering a question or objection by pointing to an old writing. The reader may not remember it or have access to it, in which case he or she doesn't really get an answer. So if an issue keeps recurring, it probably *is* worthwhile to repeat the answer from time to time, even if it doesn't change, just so new people will have a chance to see it.

All of which is simply preamble to the warning that I'm about to return to a subject I treated at considerable length way back in February 1980: quality control. I'm not just going to repeat what I said then, though, even though virtually all of it remains valid and important. This time I'm going to go beyond it and add a sinister speculation about something that I can't prove, but can't help suspecting happens oftener than we'd like to believe.

The "quality control" I'm referring to is not the usual kind. The term is often used in the narrow sense of a business trying to make sure most of the products coming off an assembly line, for instance, are properly made and function as intended. I'm using it in the considerably broader sense of controlling the overall quality of life throughout a civilization.

The central point I made in that bygone age was that the people who live in a civilization—all of them—bear the

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ultimate responsibility for making it work. You and I cannot simply assume that people, businesses, and governments will deal fairly with us and automatically deliver the quality of products and service that we're paying for. Nor must we assume that we have to put up with whatever they dish out. I pointed out numerous examples of shoddy goods and services that were commoner than they needed to be simply because people accepted them instead of complaining with enough vigor to get them changed.

People are *still* putting up with low standards, and they still hold the power to change them by insisting on higher ones. Sometimes this requires sustained, concerted action by a large group. But sometimes it doesn't. Surprisingly often, a determined individual can get something done about unreasonable treatment simply by being sufficiently insistent (and by muttering appropriate and well-timed imprecations like "Better Business Bureau").

Many people simply assume that "you can't fight City Hall," and so don't try. I've done it often enough to assure you from experience that often you *can*—but not unless you make the effort. I haven't always won, but I've won often enough to consider it worth the effort.

Sometimes you can even win things that you've been explicitly assured you can't. I recall one case in which I bought a plumbing fixture from one dealer and had it installed by an independent plumber. From the start, it had problems. The plumber said they were due to defects in the unit; the manufacturer said they were due to defective installation*. Eventually they were solved, but only after several additional visits from the plumber. The manufacturer's warranty explicitly excluded labor charges for warranty repairs, but in this case they were considerable and the unit had *never* worked right before needing repairs, so I figured the company owed me, morally if not legally. Eventually I got them to agree (grudgingly), and wound up with a letter from the president saying, "We don't do this, but here's a check."

But how many people know how to complain effectively, or are willing to take the time and trouble to do so? Relatively few, which means companies have relatively little incentive to raise their standards. Dealing with an *occasional* oddball customer who actually digs in his heels and demands that things be done right is a minor nuisance. Dealing with a *lot* of them could become a big enough headache to make a company try to do things right as a matter of course, instead of only on the rare occasions when it's forcefully demanded.

But is sloppy performance always simply a result of people's not bothering to

---

* *Yes, I learned the implicit lesson and will try to keep it in mind in future situations.*

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do things carefully? Or is it sometimes, shall we say, more consciously motivated? Here we come to my sinister speculation.

It started with a Gannett newspaper article last spring claiming that only 30% of people whose medical insurance claims are denied ever fight the decision. It didn't give the source of those figures, so I can't confirm or deny the quantitative accuracy of the claim. But it's at least qualitatively consistent with my personal experience and observations. The writer went on to point out that it's to an insurance company's advantage, if the number of people who dispute decisions is that low, to deny claims whenever they might be able to get away with it. Chances are that no one will question them and so they save money that they might otherwise have had to pay out.

Just good business practice—if all that matters is the bottom line.

This got me to thinking. How many companies make it a matter of deliberate, routine policy to try to get away with unreasonable treatment of customers, figuring that they *will* get away with it often enough to make it profitable? In the case of the insurance companies, it's probably even legal, at least in the form hypothesized above. After all, there's a certain amount of subjective judgment involved in decisions about whether to pay claims. A company that gets called on an occasional unjust denial can simply "reverse its decision on appeal," and maybe even make itself look magnanimous for admitting and correcting its error.

Then I thought of some other recent experiences. At the beginning of a trip, a suitcase arrived damaged at my destination. The nature of the damage was obvious and simple, and a repair could be done while I waited at any luggage repair shop. It *needed* to be done that way, because the suitcase would be needed throughout the trip and couldn't be carried as a suitcase until the repair was done. The obvious course of action—the *only* course of action that made any sense—was for me to take the suitcase to a local repair shop, get the job done, and let the airline responsible pay the bill, either directly or by reimbursing me later.

The airline baggage service staff told me this was quite impossible. They told me to wait till I got home, then drive to my airport and leave the case with them to send out for repair, then drive back to the airport to pick it up. This might have made some small trace of sense if I had

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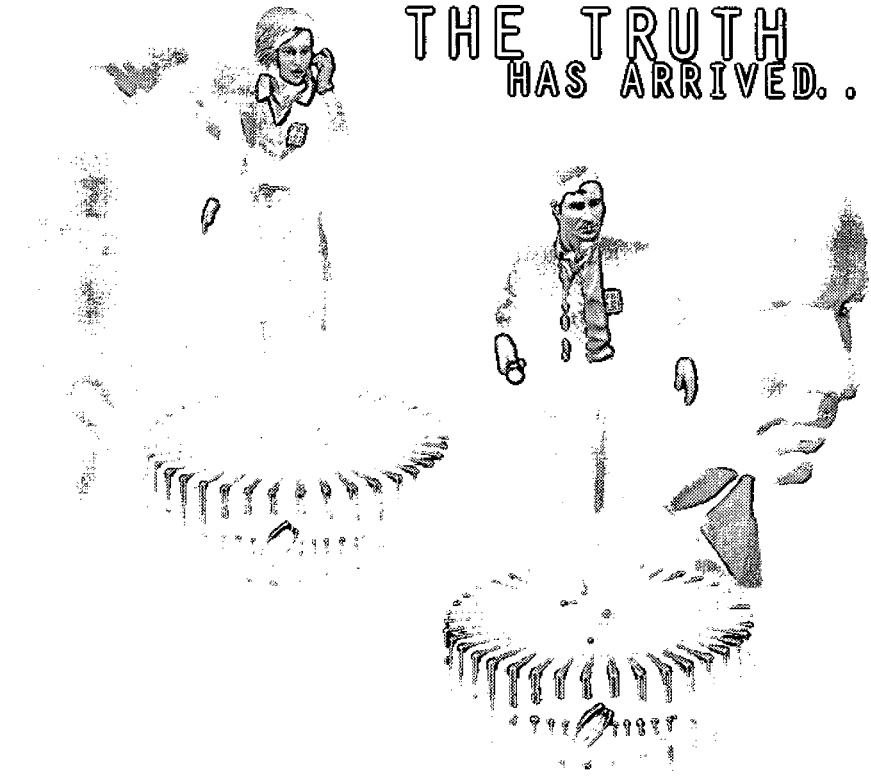

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just *finished* a trip and didn't have another scheduled soon, though even then it would have meant more than a hundred miles of unnecessary driving and a wait of at least days for a job that would take only minutes. It made *no* sense at the beginning of a trip, when it was perfectly possible to fix the problem in an easy, simple, and timely fashion. Such explanations fell on largely deaf ears, evoking empty expressions of sympathy followed by, "But there's nothing we can do. We have to follow Procedure."

No, I said, we do *not* have to follow *stupid* Procedures, and I wasn't going to accept this one. Eventually, after far too much arguing that should have been unnecessary, I got that point across and one of the agents reluctantly authorized the only sensible solution—though he obviously expected to get in trouble with his boss for doing so. What does it say about a company when an employee must fear his supervisor's ire for doing the right thing for a customer?

Later in the same trip, I turned in a rental car whose tank I had just filled. The check-in agent said the computer was down and they could mail me my receipt, or I could get a handwritten one on the spot. I chose the latter, since I prefer to get such things agreed upon while it's still possible to talk about them face-to-face if necessary. A couple of weeks later, I got a "corrected" receipt in the mail, which I first assumed was just an unnecessary duplicate. A closer look showed that the new one claimed I had turned the car in only 5/8 full, and a charge had been added to my credit card for six gallons of gas at an exorbitant rate. I immediately called the company and demanded, and got, the charge taken off. But I wondered: How many people would have bothered?

And was the extra charge an honest error, or does the company regularly make such "mistakes" in the hope that most people won't notice or bother to question them?

In the airline case, I was told in so many words, by more than one employee, that the nonsensical Procedure they wanted me to follow *was* a matter of policy, though it wasn't clear at what level (or why) that policy was set. Was it a regional official trying to make his district look good by seeing that claims were filed somewhere else, even though that would likely result in *bigger* claims and customer hostility, to the detriment of the company as a whole? Or did somebody higher up hope to increase the company's profitability by making it so difficult and unpleasant to file a claim that most customers would give up on doing so? They clearly expected *me* to just go away and quit bothering them, and were obviously disappointed when I didn't. . . .

Disturbing questions. I'm not in a position to answer them, but if anyone else is, I'd be most interested in hearing what they find out. Years ago I observed that there were a lot of slipshod goods and services in our culture, which were largely attributable to a scarcity of people insisting on fair treatment and careful attention to detail. Now I'm wondering whether some of it might be more than casual sloppiness—like a calculated effort to take advantage of the statistical truth that most people don't insist on high standards.

Whether that's true or not—whether sloppy workmanship and abusive treatment of customers are accidental or deliberate—one thing remains true. The only way to get rid of such things is for all of us to refuse to accept them. ■

The reason why we have two ears and only one mouth is that we may listen the more and talk the less.

— Zeno of Citium

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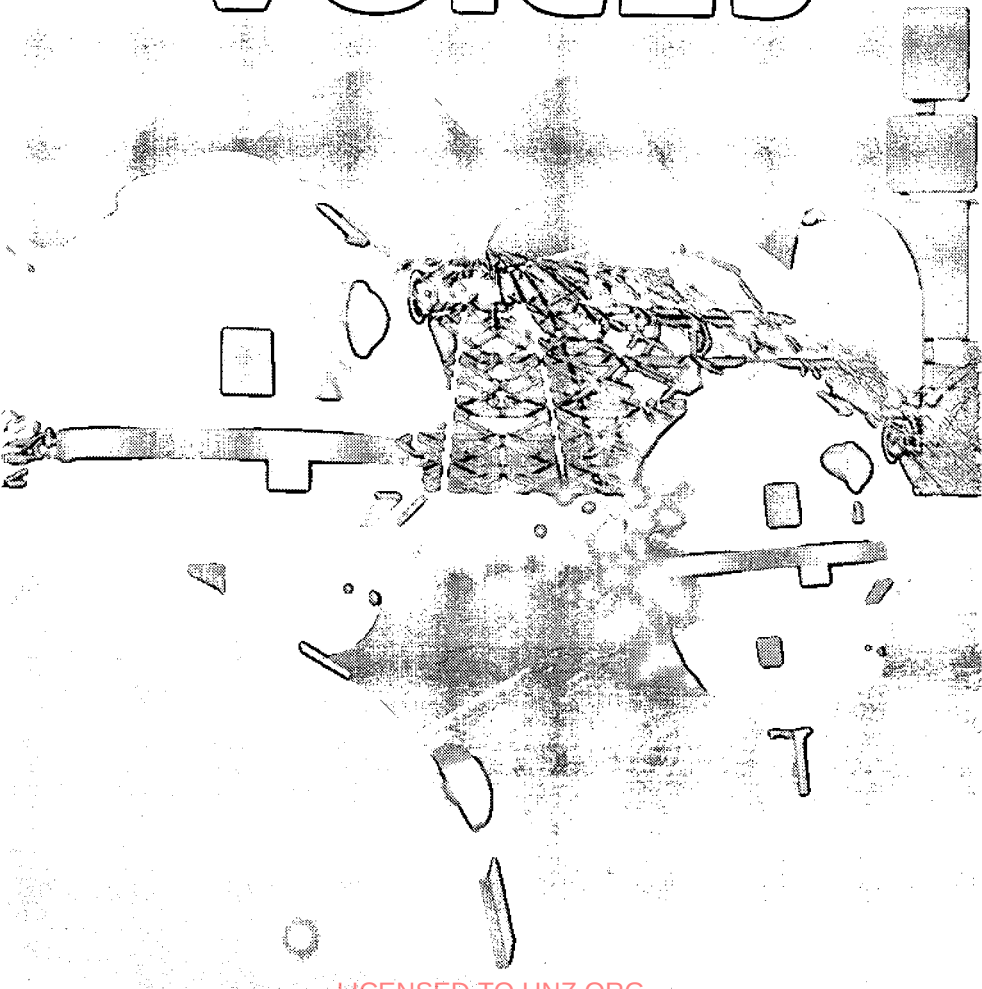
Catherine Asaro

AURORA IN FOUR VOICES



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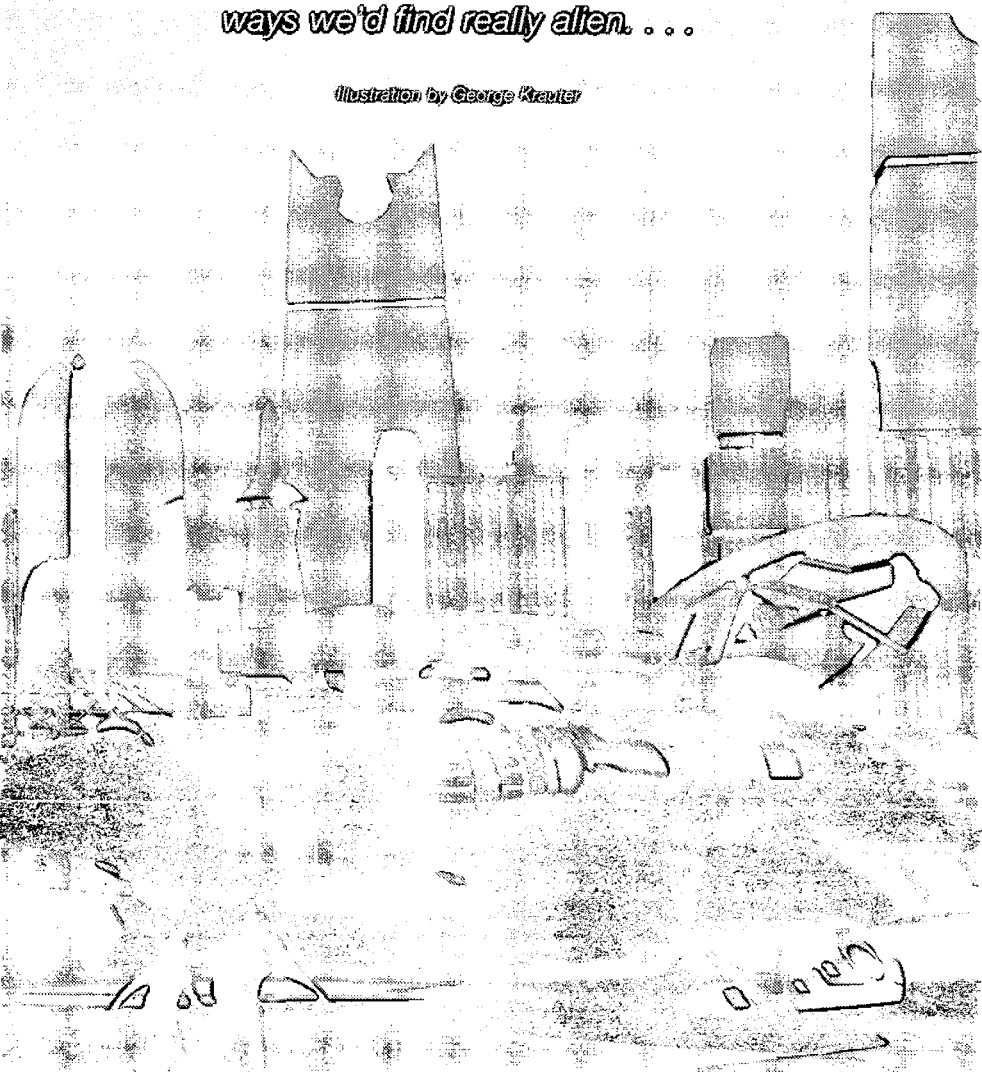
Our culture tends (somewhat hypocritically) to regard science and art as quite separate, even alien. But others might blend them in ways we'd find really alien. . . .

Illustration by George Kranter



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I
The Dreamers of Nightingale

He missed the sun.

The planet Ansatz boasts one city, Nightingale, a gem that graces eternal night. Just as a diamond sparkles because light that ventures into its heart is captured, bouncing from face to face, so Jato Stormson was trapped in Nightingale. Unlike the light inside a faceted diamond, however, he could never escape.

After a few years, his memories of home faded. He could no longer picture the sun-parched farm on the planet Sandstorm where he had spent his boyhood. It was always dark in Nightingale.

The Dreamers—the artistic geniuses who created Nightingale—were also mathematical prodigies. That was why they named their planet Ansatz. It referred to a method of solving differential equations. Guess an answer, an ansatz, and see if it solved the equation. If it didn't, make another guess. Another ansatz. Jato felt as if he were trapped on a guess of a world.

One night he went to the EigenDome, an establishment for dancing. He sat at a table and waited for the drink server, but the server never came to his table. That was why he rarely visited the Dome. The artist who had designed the place considered it aesthetic to have humans serve the drinks and the humans in Nightingale ignored him. But that night he was lonelier than usual and even the icy Dreamers were better than no company at all.

Made from synthetic diamond, the Dome resembled a truncated soccer ball. Jato had looked up its history in the city library and found a treatise on how the Dome's shape mimicked the molecule buckyball. Its holographic lighting evoked the quantum eigenfunctions that described a buckyball. He didn't understand the physics, but he appreciated the beauty it produced.

Tonight Dreamers were everywhere, dancing, talking, humming. Centuries of playing with their genes and living in perpetual night had bleached their skin almost to translucence. Their hair floated around their bodies like silver smoke. Light from lamps outside the Dome refracted through the diamond walls, gracing the interior with rainbows that collected on the Dreamers in pools of color. They glistened like quantum ghosts.

Across the Dome, the doors opened. A spacer stood in the doorway, her body haloed by the rainbow luminance. This was no Dreamer. She looked solid. Sun-touched. She must have come in on one of the rare ships that visited Nightingale; rare, because the Dreamers allowed no immigration and most sun-dwellers found a city of unrelieved night depressing anyway. The only reason people usually came to Ansatz was to trade for a Dream.

Ah, yes. The Trade.

Dreamers make a simple offer; give one a pleasant dream and in return the Dreamer will give you a work of art. They allow you ten days to try. After that, you must leave Nightingale, trade or no trade. Considering the prices Dreamer art claims throughout the Imperialate, that trade seems astoundingly one-sided, the offer of great treasure for no more than a nice dream.

Jato had let the lure of that promise fool him. He spent years saving for the ticket to Ansatz. But how do you give a dream? It was harder than it sounded, particularly given how sun-dwelling humans revolted the Dreamers. The same husky build and rugged looks that had won him such admiration back home repelled the Dreamers. Considering their disdain for ugliness, he feared they wouldn't even let him stay the ten days.

They never let him go.

So now he sat by himself and watched the spacer walk to a table across in the Dome. She wore dark pants tucked into boots and a white sweater with gold rings decorating the upper arms. Her

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clothing looked familiar, but Jato couldn't place why. She had no jacket; Nightingale's weather machines aided the planet's natural convection to keep the climate pleasant, free from the fierce winds the tore at the rest of Ansatz. Her hair was a cloud of black curls with gold tips, and dark lashes framed her eyes—green eyes, the color of a leaf in the forest. Her skin had a dusky hue, full of rosy blooming health. None of the Dreamers spared her a second look, but Jato thought she was lovely.

She sat down—and the server showed up to take her order. Irked, Jato got up and headed for the laser bar, intending to insist they serve him. Reaching it, however, was no simple feat. The Dome's floor consisted of nested rings, each slowly rotating in one direction or the other. The text he had found in the library described some business about "mapping coefficients in quantum superpositions onto ring velocities." All he knew was that it took a computer to coordinate the motion so patrons could step from one ring to another without falling. Dreamers carried it off with grace, but he had never mastered it.

He managed to reach the dance floor, a languid disk turning in the Dome's center. Dancers drifted away from him, slim and willowy, silver-eyed works of art. On the other side, he ventured into the rings again and was soon being carried this way and that. Each time he neared a hovertable occupied by Dreamers, it floated away on cushions of air. He wished just once someone would look up, admit his presence, give a greeting. Anything.

Meanwhile, the server brought the spacer her drink, which was a LaserDrop in a wide-mouthed bottle. Tiny lasers in the glass suffused the drink with color: helium-neon red, zinc-selenium blue, sodium yellow. Drink in hand, she settled back to watch the dancers.

Jato quit pretending it was the bar he wanted and headed for the spacer. But whenever he neared the ring with her hovertable, people and tables that had been drifting away suddenly blocked his path. The spacer meanwhile finished her drink, slid a payment chip into the table slot, and headed for the door. He started after her—and the drink server appeared, blocking the way, his back to Jato, his tray of laser-hued drinks held high.

Jato scowled. He had always been long on patience and short on words. But even the most stoic man could only take so much. He put his hand against the server's back and pushed, not hard, just enough to make the fellow move. The server stumbled and his tray jumped, rum splashing out of the jars in plump drops. Even then, no one looked at Jato, not even the server.

He made it to the door without pushing anyone else. Outside, lamps lit the area for a few meters, but beyond their radiance, night reigned under a sky rich with stars. Jato strode away from the Dome, his fists clenched. He didn't want to give them the satisfaction of seeing their treatment provoke him.

The Dome was on the city outskirts, near the edge of a large plateau where the Dreamers had built Nightingale. The Giant's Skeleton Mountains surrounded the plateau, falling away from it on three sides and rising in sheer cliffs on the fourth, here in the north. The northern peaks piled up higher and higher in the distance, until they become a jagged line against the star-dazzled sky.

The Dreamers claimed they built Nightingale as a challenge: can you create beauty in so forbidding a place? This was the reason they gave. Jato had heard others put forth, but the Dreamers denied them.

Although his past attempts at convincing spacers to smuggle him offplanet had failed, he never gave up. In the distant shadows, he saw the spacer climbing the SquareCase, a set of stairs carved into a cliff. The first step was one centimeter high, the second four, the third nine, and so on, their heights in-

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creasing as the square of integers. The first twenty ran parallel to the cliff, but then they turned at a right angle and stepped into the mountains, rising taller and taller, until they became cliffs themselves, too high, too dark, and too distant to distinguish.

By the time he reached the first step of the SquareCase, the spacer was climbing the tenth, about the height of her waist. She sat on it, half hidden in the dark while she watched him. He approached slowly and stopped on the ninth step.

"Can I do something for you?" she asked.

"I wondered if you wanted a guide to the city." It sounded unconvincing, but it was the best introduction he could think of.

"Thank you," she said. "But I'm fine." The conversation screeched to a halt.

He tried again. "I don't often get a chance to talk to anyone from offplanet."

Her posture eased. "I noticed my ship was the only one in port."

"Did you come to trade for a Dream?"

"No. Just some minor repairs. I'll be leaving as soon they're done."

Behind her, Jato caught sight of a globe sparkling with lights in a fractal pattern. As it floated forward, it resolved into a robot drone over a meter in diameter, its surface patterned by delicate curls of the Mandelbrot set, swirls fringed by swirls fringed by swirls in an unending pattern of ever more minute lace.

Following his gaze, the woman glanced back. "What is that?"

"A robot. It watches this staircase."

She turned back to him. "Why does that make you angry?"

"Angry?" How had she known? "I'm not angry."

"What does it do?" she asked.

"I'll show you." Jato strode forward and hauled his bulk onto the tenth step. Although he towered over the spacer, she seemed unperturbed, simply scooting over to let him pass. That self-confidence impressed him as much as her beauty.

As he approached the eleventh step, the globe whirred into his face. When he tried to push it away, it rammed his shoulder so hard he fell to one knee.

"Hey!" The woman jumped up and grabbed for him, as if she actually thought she could stop someone his size from falling over the edge. "Why did it do that?"

He stood up, brushing rock dust off his trousers. "As a warning."

That's when she did it. She smiled. "Whatever for?"

Jato hardly heard her. All he saw was her smile. It dazzled.

But after a moment, her smile faded. "Are you all right?" she asked.

He refocused his thoughts. "What?"

"You're just staring at me."

"Sorry." He motioned at the globe. "It was warning me not to go past the city border, which crosses the cliff here." Having the drones watch him up here was almost funny. As if he could actually escape Nightingale by climbing a staircase that grew geometrically.

"Why can't you leave the city?" she asked.

He discovered he couldn't make himself tell her, at least not yet. Why should she believe his story? Eight years ago, the Dreamers had showed up at his room in the Whisper Inn and locked his wrists behind his back with cuffs made from sterling silver Möbius strips. He had no idea what was happening until he found himself on trial. They convicted him of a murder that never happened and sentenced him to life in prison.

Supposedly, years of treatment had "cured" him, and he no longer posed a danger to society. So the Dreamers let him out of his cell, which had never been a cell anyway, but an apartment under the city. For a giddy span of hours he had thought they meant to send him home; if he was no longer dangerous, after all, why keep him under sentence?

He soon found out otherwise.

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For the Dreamers who believed in his guilt, which was most of them, it would take a lifetime for him to atone. One of their most renowned artists, Crankenshaft Granite, had argued—with truth—that to Jato it would be almost as much a punishment to spend his life confined to Nightingale as to his apartment. But by making the city his jail, they showed their compassion for a criminal who had turned away from his violent nature. Jato saw why that logic appealed to the Dreamers, who for some reason had a driving need to see themselves as kind, yet who in truth considered all sundwellers flawed, deserving neither freedom nor friendship.

But he knew the truth. Crankenshaft's motives had nothing to do with compassion. The only reason Jato had a modicum more freedom now was because it made Crankenshaft's life easier.

Jato didn't want to see that wary look appear on this woman's face, the one spacers always wore when they learned his story. Not yet. He wanted to have these few minutes without the weight of his conviction pressing on them.

So instead of telling her, he pointed at his feet and made a joke. "This is where I live. These are my coordinates."

"Your what?"

So much for scintillating wit, he thought. "Coordinates. This staircase is the plot of a non-linear step function."

She laughed, like the sweet ringing of a bell. "Why would anyone go to all this work just to make a big plot?"

"It's art." He wished she would laugh again. It was a glorious sound.

"This is some art," she said. "But you haven't told me why your people won't let you leave."

His people? She thought he was a *Dreamer*? It wasn't only that he bore no resemblance to them. Dreamers were gifted at both art and mathematics, neither of which he had talent for. Yet this beautiful woman thought he was both. He grinned. "They like me. They don't want me to go."

She stared at him, her mouth opening.

"Are you all right?" he asked.

She closed her mouth. "What?"

"You're just staring at me."

"I—your smile—" She flushed. "My apologies. I'm afraid I'm rather tired." She gave him a formal nod. "My pleasure at your company." Then she turned and headed down the stairs.

He almost went after her, stunned by her abrupt leave-taking. But he managed to keep from making a fool of himself. Instead, he stood in the shadows and watched her descend the SquareCase.

When Jato turned into the underground corridor that dead-ended at his apartment, he saw a Mandelbrot globe waiting at the door. Given that he lived nowhere near Nightingale's perimeter, only one reason existed for its presence. Crankenshaft had sent it. With Jato no longer confined to his apartment, Crankenshaft could have him brought wherever he wanted instead of the Dreamer having to come down here.

Jato spun around and ran, his boots clanging on the metal floor. If he could find a side passage too narrow for the globe to follow, he might evade capture. It was a stupid game Crankenshaft played; if Jato escaped the drones, Crankenshaft let him have the day off.

A whirring sound came from behind him. The drone hit his side and he stumbled into the wall, bringing up his arms to protect his face. An aperture opened on the robot and an air syringe slid out, accompanied by the hiss of its firing.

His view of the hall wavered, darkened, faded. . . .

Jato opened his eyes. A face floated above him, an aged Dreamer with eyes like ice. Gusts of wind fluttered her silver hair around her cheeks. He knew that gaunt face. It belonged to Silicate Glacier. Crankenshaft's wife.

Crankenshaft was standing behind her. Tall for a Dreamer, he had a well-kept physique that belied his one-hun-

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dred and six years of age. Black hair covered his head in bristles. He had two-tone eyes, grey bordered by red, like old ice in ruby rings.

Jato spoke in a hoarse voice. "How long?"

"You have slept several hours," Crankenshaft said.

"I meant, how long do you need me for?"

"I don't know. We will see."

As Jato pulled himself into a sitting position, Silicate stepped back, avoiding contact with him. He swung his legs over the stone ledge where he had been lying and looked around. Crankenshaft had chosen the big studio. The ledge jutted out of the west wall, an otherwise blank plane of grey stone. On the left, the south wall was a window looking over Nightingale, which lay far below. The east and north "walls" were holoscreens, sheets of thermoplastic that hung from the ceiling. Holos rippled in front of them, swaths of color that trembled as breezes shook the screens.

It always disoriented Jato, that wind. Moving air didn't belong inside a house. For that matter, neither did Mandelbrot globes. But two floated here, one hovering behind Crankenshaft and another prowling the studio.

The major feature in the room was a round pool. A glossy white cone about two meters tall rose out of the water. A second cone stood next to it, its top cut flat in a circular cross-section. The three other cones in the pool were cut at angles, giving them elliptical, parabolic, and hyperbolic cross-sections.

"Circle today," Crankenshaft said. Then he headed across the drafty studio to a console in the corner where the two holo-walls met.

Jato looked at Silicate and she looked back, as cool and as smooth as stone. Then she too walked away, leaving the studio via a slit in a thermoplastic wall.

A gust rumpled Jato's hair and he shivered, wrapping his arms around his body. "Do you have a jacket?" he asked.

Crankenshaft didn't answer, he just stooped over his console and went to work. So Jato waited, trying to clear out the haze left in his mind by the sedative.

A globe nudged his shoulder. When he stayed put, it pushed harder. "Flame off," he muttered.

A syringe extended out of the globe.

Still intent on his console, Crankenshaft said, "It shoots a heat stimulant. A strong specimen such as yourself might tolerate it for ten minutes before going into shock."

Jato scowled. Where did Crankenshaft come up with this sick stuff? He looked at the globe, at Crankenshaft, at the globe again. With Crankenshaft he used care in choosing his battles. This one wasn't worth it.

He took off his boots and went to the pool. The knee-deep water was cool today, but at least no ice crusted the surface. He waded to the truncated cone and climbed up onto it, then sat cross-legged, hugging his arms to his chest for warmth.

"Move ten centimeters to the north," Crankenshaft said.

Jato moved over. "Can you warm it up in here?"

Crankenshaft sat down at his console, concentrating on whatever he was doing. So Jato moved to the south side of the cone.

Crankenshaft looked around. "Move to the other side."

"Turn on the heat," Jato said.

"Move."

"After you turn on the heat."

Stalemate.

Reaching back to the console, Crankenshaft touched a panel. A globe whirred behind Jato and he heard a syringe hiss. Heat flared in his biceps, spreading fast, up his shoulder and down his arm.

"Hot enough?" Crankenshaft asked.

It was excruciating, but Jato had no intention of letting on how much it bothered him. He simply shrugged. "What will you do? Put your model into

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shock because he objects to freezing?"

A muscle under Crankenshaft eye twitched. He went back to work, ignoring Jato again. However, the room warmed and the burning in Jato's muscles cooled. Either Crankenshaft had lied or else the drone had delivered an antidote with the poison, probably in a bio-sheath that dissolved after a few minutes in the blood.

Over the next few hours the wind dried Jato's clothes. Silicate came in once to bring Crankenshaft a meal on a stone platter. Jato wondered about her, always attentive, always silent. Did she create her own art? Most Dreamers did, even those who worked other jobs. Silicate's only occupation seemed to be waiting on Crankenshaft. But then, Jato doubted Crankenshaft would tolerate artistic competition in his own household.

Finally Crankenshaft stood up, rolling his shoulders to ease the muscles. "You can go," he said, and left the studio.

Just like that. You can go. Get out of my house. Clenching his teeth, Jato slid off the cone and limped across the pool, sore from sitting so long. After coaxing his boots on under his wet trousers, he went to a door in the corner of the studio where the window-wall met one of the thermoplastic walls.

Icy wind greeted him outside. He stood at the top of a staircase that spiraled down the cliff Crankenshaft owned. The city glimmered far below, and beyond it ragged mountains stretched into the darkness. Millennia ago a marauding asteroid had struck the planet, distorting it into a blunt teardrop that lay on its side, its axis pointed at Quatrefoil, the star it orbited. Although Ansatz was almost tidally locked with Quatrefoil, it wobbled enough so most of its surface received at least a little sunlight. Night reigned supreme only here in this small region around the pole.

Crankenshaft's estate was high enough to touch the transition zone between the human-made pocket of calm around Nightingale and the violent winds that swept Ansatz. Yet despite the long drop to the plateau, the staircase had no protection, not even a rail. Another of Crankenshaft's "quirks." After all, he never used these stairs.

Jato grimaced. When he came willingly, Crankenshaft always had a flycar waiting to take him home. Today he would have to go back inside and ask for a ride, a prospect he found as appealing as eating rocks.

So he went down the stairs, stepping with care, always aware of the chasm of air. Around and around the spiral he went, never looking around too much, lest it throw off his balance. He wondered how he would appear to someone down in the city. Perhaps like a mote descending a stone DNA helix on the face of a massive cliff.

The helix image caught his mind. It would make an intriguing sculpture. He could go to the library and find a text on DNA. It would have to be a holobook, though, rather than anything on the computer.

Before Jato had come to Ansatz, his computer illiteracy hadn't mattered. As the oldest son of a water-tube farmer on Sandstorm, he hadn't been able to afford web access, let alone a console. Although everyone here in Nightingale had access to the city web, it did him little good. However, he had figured out how to tell a console in the library to print books.

He doubted he would try the helix sculpture, though. Reading could only give information, not talent. One thing he had to say for Crankenshaft: the man was brilliant. Jato could never imagine him giving away his stratospherically-priced work for a Dream. Besides, what Dream would he find pleasant? Pulling wings off bugs, maybe.

Jato scowled. A few Dreamers high in Nightingale's city government knew Crankenshaft had set him up. They framed him for a crime so brutal it would have meant execution or person-

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ality reconfiguration anywhere else. Imperialate law was harsh: an escaped convict fleeing into a new jurisdiction could be resentenced there for his crime. That often-denounced law was intended to ease the morass of extradition problems that arose as more and more planets came under Imperial rule. But it let Crankenshaft blackmail him; if Jato escaped Nightingale, he was subject to death or a brain wipe.

Crankenshaft's work was known across a thousand star systems. He was a genius among geniuses, and on Ansatz that translated into power. Whatever he wanted for his art, he was given.

Including Jato.

II
Dream Debt

Jato lay in bed, unable to sleep. He had dimmed the lights until only faint images of sand-swept fields softened the walls, holoart he had created himself, memories of his home.

Even after eight years, he still found this room remarkable. He had grown up in a two-room dustshack his family shared with two other families. Here he had, all to himself, a bed with a quilt, a circular bureau, a mirror, a bathroom, and soft rugs for the floor. The Dreamers charged no rent and gave him a living stipend. His medical care was free, including the light panels and vitamin supplements his sun-starved body craved.

Tonight the room felt emptier than usual. He gave up trying to sleep and went to the bureau, a round piece of furniture that rotated. He removed his statue from the top drawer. He had come to Ansatz hoping for a miracle, to trade for a fabulous treasure. He had his own dreams then, ones he hoped to achieve by selling such a masterpiece: a farm of his own, a business, a better home for his family, well-deserved retirement for his parents, a wife and children for himself. A life.

He had never intended to *make* art. Still, living in Nightingale, how could a person deny the pull to create? The statue had taken years to finish and he kept it hidden now, knowing how lacking the Dreamers would find his attempts. He liked it, though.

To get the stone he wanted, he had climbed down windscoured cliffs below Nightingale, into crevices lost in the night-dark shadows. There he cut a chunk of black marble no human hand had ever before touched. Back in his rooms, he fashioned it into a bird with its wings spread wide, taloned feet beneath its body, supported by a stand carved from the same stone. Next he made clay copies of it. He spent several years cutting facets into the copies, redoing them until he was satisfied. Then he carved the facets into the statue and inlaid them with crystalline glitter.

Dreamers used elegant mathematical theories to design their creations. Jato knew his was simple in comparison. The geometry of the facets specified a fugue in four voices, each voice an aspect of his life: loss, of his home and life on Sandstorm; beauty, as in the stark glory of Nightingale; loneliness, his only companion here; and the dawn, which he would never again see.

Holding the statue, he lay down in bed and fell asleep.

The bird sang a miraculous fugue, creating all four voices at once. Jato held it as he ran through Nightingale. The pursuing Mandelbrot drone gained ground, until finally it whirred around in front of him. Fractals swirled off its surface and turned into braided steel coils. They wrapped around his body, crushing his chest and arms, silencing the bird. He reeled under the icy stars and fell across the first step of the SquareCase.

He wrestled with the coils until he worked his arms free, easing the pressure on the bird. It sang again and its voice rose to the stars on wings of hope.

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The fractal coils fell away from his body. As Jato stood up, the spacer appeared, walking out of the shadows that cloaked the SquareCase. She toed aside the coils and they melted, their infinitely repeating patterns blurred into pools of glimmering silver. The bird continued to sing, its fugue curling around them in a mist of notes.

The spacer stopped only a pace away. Her eyes were a deep green, dappled like a forest, huge and dark. She brushed her fingers across his lips. Jato put his hand on her back, applying just enough to pressure to make the decision hers; stay where she was, or step forward and bring her body against his.

She stepped forward. . . .

The Whisper Inn was a round building, graceful in the night. Holding his bundle, Jato stood at its door, an arched portal bordered by glimmering metal tiles.

"Open," he said.

Nothing happened.

He tried again. "Open."

Swirling lines and speckles appeared on the door and a holo formed, an amber rod hanging in front of the door. A curve appeared by the rod and rotated around it, sweeping out a shape. When it finished, a vase hung in the air with the rod piercing its center. Soothing pastel patterns swirled on the image.

"Solid of revolution complete," the door said. "Commence integration."

"What?" Jato asked. No door had ever asked him to "commence integration" before.

"Shall I produce a different solid?" it asked.

"I want you to open."

Silver and black swirls suffused the vase. "You must calculate the volume of the solid."

"How?"

"Set up integral. Choose limits. Integrate. Computer assistance will be required."

"I have no idea how to do that."

"Then I cannot unlock."

Jato scratched his chin. "I know the volume of a box."

The vase faded and a box appeared. "Commence integration."

"Its volume is width times height times length."

Box and rod disappeared.

"Open," Jato said.

Still no response.

Jato wondered if the Innkeeper had his door vex all visitors this way. Then again, Dreamers would probably enjoy the game.

"Jato?" the door asked.

"Yes?"

"Don't you want to enter?"

He made an exasperated noise. "Why else would I say 'Open'?"

Box and rod reappeared. "Commence integration."

"I already did that."

"I seem to be caught in a loop," the door admitted.

Jato smiled. "Are you running a new program?"

"Yes. Apparently it needs more work." The door slid open. "Please enter."

Muted light from laser murals lit the lobby. As the floor registered his weight, soft bells chimed. Fragrances wafted in the air, turning sharp and then sweet in periodic waves.

The Innkeeper's counter consisted of three concentric cylinders about waist height, all made from jade built atom-by-atom by molecular assemblers, as were most precious minerals used in Nightingale's construction. The Innkeeper sat at a circular table inside the cylinders, reading a book.

Jato went to the counter. "I'd like to see one of your customers." He knew the spacer had to be here; this inn was the only establishment in Nightingale that would lodge sun-dwellers.

The Innkeeper continued to read.

"Hey," Jato said.

The Dreamer kept reading.

Jato scowled, then clambered over

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the cylinders. "The offworld woman. I need her room number."

The Innkeeper rubbed an edge of his book and the holos above it shifted to show dancers twirling to a Strauss waltz.

Jato pulled the book out of his hand. "Come on."

The Innkeeper took back his book without even looking up. A whirring started up behind Jato, and a Mandelbrot globe bumped his arm.

"I owe her," Jato said. "She gave me a dream."

That caught the Dreamer's attention. He looked up, his translucent eyebrows arching in his translucent face. "You come with Dream payment?" He laughed. "*You?*"

Jato tried not to grit his teeth. "You know payment has to be offered."

"She is in Number Four," he said.

Jato hadn't actually expected a reply. Apparently the unwritten laws of dream debt overrode even the Innkeeper's distaste for talking to large, non-translucent people.

Old-fashioned stairs led to the upper levels. As Jato climbed, holoart came on, suffusing the walls with color. He glanced back to see the holos fade until only sparks of light danced in the air, mimicking the traces left by particles in an ancient bubble chamber.

No one answered when he knocked at Number Four. He tried again, but still no answer.

As he started to leave, a click sounded behind him. He turned back to see the spacer in the doorway, light from behind her sparkling on the gold tips of her tousled hair. She wore grey knee-boots and a soft blue jumpsuit that accented her curves. The only decorations on her jumpsuit were two gold rings around each of her upper arms. A tube trimmed each of her boots, running from the heel to the top edge of the boot, an odd style, but attractive.

"Yes?" she asked.

Jato swallowed, wondering if he had just set himself up for a rebuff. He tried to think of a clever opening that would put her at ease, perhaps intrigue or even charm her. What he ended up with was the scintillating, "I came to see you."

Incredibly, she stepped aside. "Come in."

Her room was pleasant, with gold curtains on the windows and a pretty rumpled bed that looked as if she had been sleeping in it.

Jato hesitated. "Did I wake you? I can come back later."

"No. Now is good." She motioned him to a small table gleaming with metal accents. Its fluted pedestal supported two disks, the upper joined to the lower along a slit that ran from its center to its rim, a style common in Nightingale. The only explanation Jato had ever extracted from a Dreamer was, "Riemann sheets." He had looked it up at the library and found an opaque treatise on complex variable theory that apparently described how the sheets made a multi-valued expression into a mathematical function.

After they sat down, he set his bundle in front of her and spoke the formal phrases. "You gave me a dream. I offer you my work in return."

She watched his face. "I don't understand."

"A beautiful dream." He wondered if he sounded as awkward as he felt. "This is what I have to trade." Pulling away the wrapping, he showed her the bird. Giving it up was even harder than he had expected. But it was a matter of honor: he had a debt and this was the only payment he had to give.

As she sat there staring at his life's creation, his face grew hot. He knew the wonders she had seen in Nightingale. The bird was pitiful in comparison.

"It makes music," he said. "I mean, it doesn't make the music but it tells you how to make it."

She looked up at him. "Jato, I can't accept this." An odd expression crossed her face, come and gone too fast to decipher. If he hadn't known better, he

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would have thought it was awe. Then she said, "Regulations don't allow me to accept presents."

Through the sting of her refusal, he realized what she had said. "How did you know my name is Jato?"

"After we talked, I looked up your Ansatz records."

He stared at her. Those records were *sealed*. That was the deal; as long as he did what Crankenshaft wanted, his records remained secret and he had his relative freedom on Ansatz.

Somehow he kept his voice even. "How?"

"I asked," she said. "The authorities had to let me."

Like hell. They were supposed to say *No*. Had his presence become so offensive that they decided to get rid of him despite Crankenshaft? Or maybe Crankenshaft no longer needed him.

Then it hit Jato, what else she had said. Regulations didn't allow her to accept gifts. *Regulations*.

Of course. He should have recognized it earlier. The gold bands on her jumpsuit were no decorations. They denoted rank.

"You're an ISC soldier," he said.

She nodded. "An Imperial Messenger. Secondary Class."

Jato stared at her. Secondary was equivalent in rank to colonel and "Messenger" was a euphemism for intelligence officer. He had almost asked a high-ranking spy-buster to smuggle him off Ansatz.

ISC, or Imperial Space Command, was the sole defense in known space against the Traders, whose military made a practice of "inviting" the settled worlds to join their growing domain. All settled worlds. Whether they wanted to join or not. The Traders based their economy on what they called "a benevolent exchange of work contracts designed to benefit both workers and the governing fellowships that hold their labor contracts," one of the more creative, albeit frightening, euphemisms Jato had heard for slavery. The Imperialate had formed in response, an attempt by the free worlds to remain that way. That was why so many colonies, including Ansatz, had joined the Imperialate despite the loss of autonomy that came with ISC's autocratic control.

He spoke with a calm he didn't feel. "Are you going to turn me over to ISC?"

"Well, no," she said. "I just wondered about you after you followed me up those strange stairs."

Relief swept over him, followed by distrust, then resentment, then embarrassment. One of his few comforts on Ansatz had been his pleasure in creating the bird. Now every time he looked at it he would remember how she rejected it.

As he rose to his feet, an emotion leapt across her face. Regret? It was mixed with other things, shyness maybe, even a fear of rejection. It went by too fast for him to be sure.

She stood up. "May I request an alternate gift? Something that wouldn't violate regulations?"

He had no alternate gifts. "What do you mean?"

"I'd like to see Nightingale." She hesitated. "Perhaps you would show it to me?"

She wanted a guide? True, he was the best candidate; the Dreamers would never deign to offer such services. But most people would prefer no guide at all to a convicted murderer.

Of course his records said he was "cured." Besides, rumor claimed Messengers had enhanced speed and strength. Perhaps she was confident enough in her abilities that she didn't see him as a threat.

"All right," he said.

"Well. Good." It came again, her beguiling flash of shyness. "Shall we, uh, go?"

He smiled. "It would help if I had a name to call you."

"Oh. Yes. Of course." She actually reddened. "Soz."

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"Soz." He gave her a bow from the waist. "My pleasure at your acquaintance."

Her face softened into a smile. "And mine at yours."

They walked down to the lobby in awkward silence. Outside, they strolled through the Inn's rock garden, where tall lamps made shadows stretch out from human-sized mineral formations. The arrangement of rocks looked random, but it had an underlying order calculated from chaos theory.

As they followed a path toward the city proper, Jato tried to relax. Conversation had always been his stumbling block. In his adolescence, he had discussed it with is father while they were weeding a field.

"About girls," he had said.

"What about them?" his father asked.

"You know."

His father sat back on his heels. "Treat her right and she'll treat you right."

"Can't talk."

"Then listen."

"Don't know what 'treat her right' means."

"The way you want to be treated."

Jato thought of having a girl treat him the way he wanted to be treated. "What if we get into trouble?"

His father scowled. "Don't."

He had figured that his father, who became his father only a few tendays after he married Jato's pregnant mother, would have had a more informative answer than that. "What if it happens anyway?"

"You see that it doesn't." He pointed his trowel at Jato. "You go planting crops, boy, you better be ready to take responsibility if they grow." Lowering his arm, he looked across the field to where Jato's mother was curing tubes by the water shack, her long hair brushing her arms, Jato's five younger siblings helping her or playing in the dust. "Choose a place you value." His voice softened. "A place you can love."

Jato watched him closely. "Did you?"

He turned back, his face gentle now. "That I did."

That was the extent of his father's advice on women, sex and love, but it had held up well over the years. On Nightingale, however, he barely ever had the chance to talk to a woman, let alone go walking with one. So being with Soz felt odd.

Eventually the path became a boulevard. They ended up at a plaza in front of Symphony Hall, near the tiled pool. A lamp came on, bathing the pool in rosy light, and a fountain shot out of the water in a rounded arch. A gold lamp switched on, followed by a fountain with two arches, then a green lamp and three arches, and so on, each fountain adding smaller refinements to the overall effect. Altogether, they combined to create a huge blurred square. Sparkles of water flew around Jato and Soz and mist blew in their faces.

"It's lovely," Soz said.

Jato watched her, charmed by the way the rainbow-tinged mist haloed her head, giving her pretty face an ethereal aspect. She looked like a watercolor painting in luminous colors. "It's called the FourierFount," he said.

She smiled. "You mean like a Fourier series?"

"That's right." He restrained himself from blurting out how much he liked her smile. "The water arches can't combine like true wave harmonics, but the overall effect works pretty well."

"It's unique." She glanced down at his hands. "Jato, look. Your bird."

He held up the statue and saw what she meant. Light from the fountain was reflecting off the glitter so that it surrounded the statue with a nimbus of rainbows.

She held out her hands. "May I?" He handed it to her, and she turned it this way and that, watching the shimmer of light on its facets. "What did you mean, that it makes music?"

"The angle of each facet defines a note." He wondered if he even had the

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words to explain. Before composing the fugue, he had tried to learn music theory, but in the end he just settled for what sounded right. He played no instruments, nor could he make notes in his mind without hearing them first. He needed a computer to play his creation. The Dreamers steadfastly ignored his requests for web training, so he muddled through on his own, eventually learning enough to use one particular console in the library.

"Could I hear the music?" Soz asked.

Her request touched off an unexpected spark of panic. What if she scorned what she heard, the musical self-portrait he had so painstakingly crafted? "I can't play it," he said. "It needs four spherical-harmonic harps."

"We can have a web console do it."

He almost said no. But he owed her for the dream and playing the fugue would pay his debt. Going on a walk through Nightingale didn't count; dream debt required a work of art created by the debtor.

Still he hesitated. "It's a long way to the console I use."

She motioned at Symphony Hall. "That building must have public consoles."

He could imagine what she would think of a grown man who could barely log into the web of a city where he had lived for years. He paused for a long time before he finally said, "Can't use them."

"It has no console room?"

"It has one."

"Can't you link to your personal console from here?"

His shoulders were so tense, he felt his sweater pulled tight across them. "No personal console."

She blinked. "You don't have a personal console?"

"No."

"Where do you work?"

"Library."

"We can probably link into the library system from here." She watched his face as if trying to decipher his mood. "I can set it up for you."

So. He had run out of excuses. After another of their awkward pauses, he said, "All right."

He took her to an alcove in Symphony Hall. Blue light filled the room and blue rugs carpeted the floor. The sculpted white shapes of the public consoles made a pleasing design around the perimeter of the room.

Soz sat on a cushioned stool in front of the nearest console. "Open guest account."

When a wash of blue appeared the screen, Jato almost laughed. Only Dreamers would color-coordinate a room's decor with its web console.

"Welcome to Nightingale," the console said. "What can I do for you?"

"Library access," she said. "Establish a root directory here, standard branch structure and holographics, maximum allowed memory, full paths to available public nodes, and all allowed anonymous transferral options."

"Specify preferred nodes," the console said.

"One to produce a music simulation, given a representation of the score and a mapping algorithm."

A new voice spoke in mellow tones. "Treble here. Please position score and define algorithm."

Soz glanced at Jato. "You can take it from here."

He just looked at her. It had sounded like she was speaking another language. He hadn't even known the computers she spoke to existed. "Take it where?"

She stood up and moved aside. "Tell Treble how to access your files."

"I don't have an account."

"Everyone has an account."

He had to make a conscious effort to keep from gritting his teeth. "I guess I'm no one."

Soz winced. "I'm sorry. I didn't mean it that way." She started to say more, then stopped. Glancing around the alcove, she said, "This room must be easy to monitor."

"Probably." Did she think the Dream-

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ers were watching them? "The drones keep track of me."

She nodded. Any questions or comments she had intended to make about his lack of computer accounts remained unsaid. Instead she indicated a horizontal screen on the console. "If you put the statue there and give Treble the mapping for the fugue, it will make a hologram of the bird, digitize it, transform the map, and apply the transform to the digitized data."

Jato wished he were somewhere else. This was worse than the business with the door at the Inn. At least then he had been revealing his ignorance to an inanimate object. "I've no idea what you just said."

Incredibly, she flushed, as if she were the one making an idiot out of herself rather than him. "Jato, I'm terrible at this. Ask me to calculate engine efficiency, plot a course, plan strategy—I'm a whiz, like you with your art. Put me in front of a handsome man and I'm as clumsy with words as a pole in a pot."

He stared at her. A whiz . . . *like you with your art*. She thought he was a "whiz." A handsome whiz, at that.

Jato smiled. "You're fine." He motioned at the console. "So I put the statue there?"

Her face relaxed. "That's right. Then tell Treble how to figure out the notes."

He set down the bird, and two laser beams played over it, making the glitter sparkle. When they stopped, he said, "Treble?"

"Attending," the console answered.

"The angle a facet makes with the base of the bird specifies a note. It varies linearly: facets parallel to the base are three octaves below middle C and those perpendicular are three octaves above." He touched the statue, his fingertips on its wings. "Each plane parallel to the base defines a chord and each facet touching the plane is a note in that chord. To play the fugue, start at the bottom and move to the top."

"Is height a discrete or continuous variable?"

"Continuous." Only a computer could do it. Human musicians would have to take planes at discrete heights. If the intervals between the planes were small enough, the human version approached the computer version. But the fugue only truly became what he intended when the distance between planes was so small that for all practical purposes it went to zero.

"Facets with one ridge are played by a spherical-harmonic baritone harp," he said. "Two ridges is tenor, three alto, and four soprano. Loudness is linear with glitter thickness, from pianissimo to fortissimo. Tempo is linear with the frequency of the light corresponding to the glitter color." He tapped a beat on the console. "Red." He increased the tempo. "Violet."

"Data entered," Treble said. "Any other specifications?"

"No." Then, realizing he would have to see Soz's reaction to the music, Jato said, "Yes. Lower the room lights to fifteen percent."

The lights dimmed, leaving them in dusky blue shadows. It was too dark to see Soz's face clearly.

A deep note sounded, the rumbling of a baritone harp. After several measures of baritone playing alone, tenor joined in with the same melody, mellow and smooth. Alto came next and soprano last, as sweet as the dawn.

Treble shaped the music far more tenderly than the generic program he used in the library. Yes, that was it, the minor key there, that progression, that arpeggio. Treble had it right. At the bird's arching neck, soprano soared into a shimmering coloratura. Notes flowed over them, radiant and painful, too bright to endure for long. The other harps came in like an undertow, pulling soprano beneath their deeper melodies. At the head of the bird, soprano burst free again, a fountain of sound.

Yes. Treble had it. Treble knew.

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Gradually the music slowed, sliding over the outstretched wings above the bird. Finally only baritone rumbled in the glimmering wake of soprano's fading glory. The last notes vibrated in the alcove and died.

Jato stood frozen, afraid to move lest it rouse Soz to reveal her reaction. Yet the silence was also unbearable. What did she think? That was him in that music, the vulnerable part, without barriers or protections.

Her head was turned toward the console, so he saw only her profile. A glimmer showed on her cheek. Something was sliding down her face.

He touched the tear. "Why are you crying?"

"It's so beautiful." She looked up at him. "So utterly sad and utterly beautiful."

Beautiful. She thought his music was beautiful. He tried to answer, make a joke or something, but nothing came out. So he drew her into his arms and laid his cheek on top her head.

She didn't pull away. Instead she put her arms around his waist and held him. The fresh scent of her newly washed hair wafted around him. Softly she said, "What place do you like best in Nightingale?"

"The Promenade."

"Will you take me there?"

He swallowed. "Yes."

III
The Giant's Rib

Bathed in starlight, the west edge of the plateau dropped into the jagged immensity of the Giant's Skeleton Mountains. Its crevices cut deep into the planet's crust, the tormented remains of a planetoid impact that had brutalized Ansatz in a long-vanished eon. Spires jutted up like skeletal fingers on walls between the chasms.

Natural bridge formations tried to span the kilometers-deep fissures, but most spans were incomplete, their broken ends hanging in the air.

The plateau itself claimed one of the few unbroken bridges. The Promenade. It rose up from the plateau's southern corner, spanned its length, and ended high in the northern cliffs. Two kilometers long and averaging only two meters wide, the bridge curved out from the plateau over a great chasm. Spires on the chasm walls supported it with columns of rock.

The Dreamers had tooled the Promenade's upper side into a path, giving it meter-high retaining walls on both sides. They laid down a courtyard at its southern base, with undulating lines enameled into the geometric design of gilded tiles.

As Jato and Soz crossed the courtyard, wind grabbed his jacket and tossed her curls around her face. She said something, but he couldn't hear her over the blustering wind, so he leaned down. "Say again?"

Her breath tickled his ear. "It's exhilarating."

"It's even stronger on the Promenade."

"Beat you there!" She took off and sprinted up the bridge, leaning forward against its steep cant. Laughing, he tried to catch her, but she ran like a rocket.

They raced the entire kilometer to the apex. At the top, Soz threw out her arms and spun around, her hair whipping about her head. She spoke and the wind kidnapped her words. When Jato shook his head and pointed to his ears, she shouted, "How far to the bottom?" Then she leaned over the wall, staring into the void below.

"Three kilometers!" He pulled her back to safety turning her around, his bird pressed against her back, his pulse beating hard as the bridge vibrated in the rushing gales. She looked up at him with a flushed face. The wind, the night, the danger—it brought her alive. Without stopping to think, he pulled her into an embrace.

Sliding her arms around his neck, she drew his head down into a kiss. He returned the favor with pleasure, making

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up for eight years of solitude. He couldn't believe this, that she wanted him. Who would have thought it?

Jato paused. Why did she want him? Lifting his head, he looked down at her. He was trapped on Ansatz for life and they both knew she would soon leave. What was this, take advantage of the love-starved convict, then go back to her life where she didn't have to worry about him?

Soz watched his face, her eyes alternately visible and hidden as the wind threw around her hair. She touched his cheek with fingers as gentle as the smile that kept emerging and hiding behind those glorious curls. Jato decided the "why" didn't matter. He wanted to tell her things, how good she felt, how lovely she looked, but he couldn't think of anything that wouldn't sound clumsy. So instead he kissed her again.

The bridge's vibrations were increasing, making it pitch like the deck of a sea-ship. It gave a particularly inspired heave and knocked Soz and Jato apart, separating them as if it were their chaperon. They stumbled back from each other, both flailing their arms for balance. Jato laughed and Soz spread her arms wide as if to address the Giant's Skeleton itself with her protest.

Then something on the plateau caught her attention. She went back to the wall and peered toward Nightingale. "What are those?"

Looking out, Jato saw what she had noticed, the familiar statues, massive and tall, halfway between the plateau's edge and the city. Sometimes those gigantic stone beasts were lit and other times they stood in the dark, like now, their mouths forever open in silent roars.

"Wind Lions," Jato said. Coming to stand behind her, he put his arms around her waist. "Wind machines. If they were ever turned on, the cliffs would magnify their effect."

"No wonder it's so windy up here."

He bent his head and spoke against her ear. "This is normal wind. The Lions aren't on."

When his breath wafted against her ear, she closed her eyes and sighed. With her back against his front, she raised her arms and slid them around his neck. The motion pulled up her breasts, making her nipples point at the stars. He kissed her ear, and she rubbed her head against his cheek like a cat. Then she murmured, a soft noise audible only with his head so close to hers, one of those sounds he had forgotten a woman made when she liked the way a man touched her. Maybe it was the eight years of solitude, but he couldn't remember any woman on Sandstorm feeling this fine. He wondered how it would be to make love up here in the wild gales, three kilometers above the Giant's chasm.

"Why not?" she asked.

He smiled. Why not indeed? "Why not what?"

She lowered her arms and turned in his embrace. "Why aren't the Lions ever on?"

He tilted his head toward the courtyard. "Do you remember the design in the tiles back there? The curving lines?" When she nodded, he said, "It's a plot of the vortices for a single-degree oscillator with an undamped torsional flutter." He stroked her blowing curls back from her face. "Wind makes the Promenade twist. If it ever blew hard enough, the vortices in its wake around the bridge would drive a self-induced resonance until the Promenade tore itself apart."

"What would ever possess them to set it up like that?"

Jato smiled. "Because they're crazy." As he bent his head to kiss her, the bridge gave a violent shudder and threw them to the side. They stumbled along the wall, lurching from side to side as they struggled to regain their footing. It didn't work; they finally toppled over and hit the walkway with a thud.

"Hey!" Soz laughed, struggling to wriggle out from under Jato's bulk. "It's mad at us."

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"I've never seen it this windy." Jato managed to get up to his knees, but when Soz tried to do the same, the agitated bridge knocked her over again. She finally succeeded by moving with an unnatural speed, as if she had toggled a switch that activated an enhanced mode of her body. They knelt there face to face, Jato holding her shoulders, she with her hands braced against his chest. The Promenade kept moving, more than he had ever felt it do before, rippling almost. It moaned in the assault of air as if the Giant were waking from his mountainous grave.

Soz wasn't smiling any more. "The Lions are blowing."

He couldn't believe it. "That's impossible. The Dreamers consider this art. They would never destroy it."

"The whole bridge is shaking. It doesn't feel stable."

They stared at each other. Then they scrambled to their feet and took off running for the northern cliffs. The cliffs were closer than the courtyard, but even so they had nearly a kilometer to go.

Suddenly the bridge lurched like a string shaken by a mammoth child. Flailing for a handhold, Jato pitched into the wall and found himself staring at the chasm below. In the same instant that he jerked back, Soz pulled him with unexpected strength. Their combined effort sent them reeling across the bridge into the other wall.

Then it came: a great booming crack. Thunder roared as if a great mountainous rib was tearing away from the Giant's skeleton. The bridge convulsed and they sprawled forward, slammed down onto the path. Rolling onto his side, Jato grabbed Soz and they held on to each other while the universe convulsed around them.

Within seconds the frenzied gyrations of the bridge eased. They managed to sit up, hanging onto each other while they stared back along the way they had come.

Meters away, the broken end of the Promenade hung in the air.

For one endless instant they stared at the jagged remains of that break. The shuddering edge shook off a chunk of itself, and the boulder dropped into the void below, hurtling into the shadows.

Carefully, so very carefully, they got to their feet and backed away, taking each step as if they were in a mine field. Only when they were well away from the break did they turn.

And then they *ran*.

The Promenade groaned in the onslaught of wind. They sped through a universe of wailing gales and convulsing rock, racing toward the shadowed bulk of a mountain that seemed an eternity distant.

Finally, mercifully, they were almost there. A few more steps—

A meter away from safety, the bridge pitched under their feet and slammed them against the wall. Stars wheeled past Jato's vision as he flipped over the barrier. He grabbed at the air, at the rock, *anything*—

With a wrenching jolt, he yanked to a stop. He had caught a projection and was hanging from it, his body dangling against the outer side of the Promenade. He scrabbled for a toehold, but the bridge was shaking too much to let him get purchase. Far below, the chasm waited.

His hands began to slip.

"Jato!" Soz's voice was almost on top of him. She had fallen lengthwise on the wall, with one leg hanging over the edge.

"Below you!" he shouted. His hands slipped again.

As she grabbed for him, he lost his grip. She caught one of his wrists—and the force of his falling yanked her off the wall. They dropped, dropped, dropped—

And smashed into ground. Soz landed on top of him with an impact that nearly broke his ribs. She rolled off and kept rolling, scrabbling for a handhold. He clutched her upper arm, but it jerked

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through his grasp, then her elbow, her lower arm, her wrist—and he locked hands with her, clutching in desperation while they slid downhill. He struggled to stop their plunge, but his fingers just scraped over stone.

Then he caught a jutting piece of rock and held on hard, his body straining with Soz's weight. A scratching came from below—and she let go of his hand.

"Soz, no!" He grabbed at the air. "Soz!"

"It's all right." Her strained voice came from below him. "You slowed me down enough so I could stop on a ledge. We're on a shelf in the cliff, under the Promenade."

"How can you tell? It's dark." Even the starlight was muted below the bridge.

"Got enhanced optics in my eyes," she said. He heard more scrabbling, and then she was pulling herself up beside him.

So they went, climbing the cliff centimeter by excruciating centimeter. Soz reached the landing at the end of the Promenade and stood up, her body silhouetted against the stars. He climbed up next to her, half expecting the ground to crumble. But they were solidly on the mountain now, at the top of a staircase that wound its way through the mountains down to the plateau.

They descended in silence. Gradually the wind eased, until it was no more than a whisper of its earlier violence.

Finally Soz said, "Someone knew we were up there."

"The drones." Jato wondered if Crankenshaft had set alarms in the city computer web to alert him when anyone looked at records of the trial. Whoever had set the Wind Lions against them would be desperate now, knowing they had to complete what they started lest Soz escape and report back to ISC.

"I hadn't intended to get involved here," Soz said. "I was going to wait until I got back to headquarters to recommend they send an investigator."

Investigator? Jato stiffened. If ISC got into this, he could be retried in an Imperial court. "Soz, why? I'm serving the sentence they gave me."

She spoke quietly. "To find out why someone went to so much trouble to trump up that phony murder charge against you."

That threw him. Really threw him. Crankenshaft had been meticulous in setting up the evidence, specifically to fool people like Soz.

It was a moment before he found his voice. "How did you know it was false?"

She snorted. "I saw the holos of that kid you supposedly killed. He was hanging around the port docks, watching a ship unload cargo."

"'That kid' was a computer creation. He never existed."

"I know."

"But how?"

She motioned toward the starport. "In several holos you can see the ship he's watching. It's a Tailor Scout, Class IV. Eight years ago those Tailors were using non-standard flood lamps to light their docking bays. Kaegul lamps. Advertised as 'the next best thing to sunlight.' They emitted ultraviolet light as well as visible."

"Sounds reasonable."

She shook her head. "Their UV component was too strong. It caused sunburns. So that model fell out of use fast. Only a few ships ever carried it."

Jato whistled. "Dreamers have less melanin in their skin than most people. It makes them more susceptible to UV."

Quietly she said, "Any Dreamer who spent as long under those Kaeguls as they claimed that boy did would have been broiled raw. Those records are beautiful, near perfect. Probably 99.9 percent of the people seeing them would have been fooled. But they're still fakes." Glancing at him, she added, "That's not all."

"What else?"

"Combat."

"Combat?"

"See enough of it and you get good at recognizing the symptoms of shock."

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She watched his face. "You. In every holo. You hardly said a word throughout that entire trial."

The whole nightmare was a blur in his mind. "Nothing I said would have made any difference."

"But why, Jato? Judging from how the Dreamers treat you—forgive me for saying it, but they act as if they don't like having you around."

"They think I'm revolting."

"So why make you stay?"

His voice tightened. "Because of Granite Crankenshaft."

"What is that?"

"Not what. Who. A Dreamer. He wanted me to be his model. For life. To sit for him with nothing in return but the 'honor' of living here. I told him no. I thought he was crazy."

She stared at him. "He framed you for murder because you wouldn't be his model?"

"I don't know why. He finds me as repulsive as everyone else here." Jato spread his hands. "He used blackmail because it's more effective than abduction. As long as I cooperate, he won't call in the Imperial authorities."

"All because he wants to paint your picture?"

"Not paint. Holosculpture. It's on his web. I've never seen what he's doing." He exhaled. "The stakes are high, Soz. His sculptures bring in millions. A few have gone for billions."

She drew him to a stop. "This Crankenshaft—does he have glittering hair?"

"I don't know. It's too short to tell."

"Black?"

"Yes."

"How about his eyes?"

"Grey, with red rings."

"Bloodshot?"

"No. The irises have red in them."

She blew out a gust of air. "This is making more sense."

"It is?"

"The Traders established this colony."

It wasn't her comment that surprised him, but how she said it, as an accepted fact rather than a long-debated theory the Dreamers vehemently denied. The Traders were a genetically engineered race distinguished by red eyes, and black hair with a distinctive shimmering quality. Their creators had only been trying to engineer for a higher pain tolerance, but the work produced an unplanned side-effect: Traders felt almost no emotional pain either—they had no compassion.

A race with no compunction about hurting people could do a lot of damage. Fast. When they began to spread the stain of their brutality across the stars, the colonized worlds had two choices: submit to them or join the Imperialate. As far as Jato knew, no one had ever willingly chosen the Traders.

There were those who claimed the Dreamers descended from a group of Trader geniuses morally opposed to their own brutal instincts. They manipulated their genes to rid themselves of those instincts and produced their translucent coloring as an unexpected side-effect. It led them to settle on Ansatz in the forgiving dark, where they traded the fruits of their genius for dreams, in penance for the sins of their violent siblings.

"It's possible Crankenshaft carries throwback genes," Jato said. "His wife, too. She's like ice."

Soz considered him. "You realize that except for your eyes and the relative dullness of your hair, you could pass for a Trader."

He stiffened. "Like hell. I can trace my family—"

"Jato." She laid her hand on his arm. "No one would ever mistake you for a Trader. It's the Dreamers' problem, not yours. They evolved themselves into a mild people, rejecting their heritage. Your large size, dark hair, and muscular build may stir memories they can't deal with. It's probably why your appearance bothers them."

A strange thought, that. It would nev-

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er have occurred to him that perhaps he repulsed the Dreamers because he reminded them of themselves.

She peered down the stairs, though they were too far up to see much except the lonely circle of light from a lamp at the bottom. "Who do you think activated the Wind Lions?" She turned back to him. "Are we up against the city government or this Crankenshaft? Or both?"

He considered. "Most city officials don't believe I was set up. Those few involved with the set up would be more subtle, use a scenario easier to pass off as an accident. This is Crankenshaft's style. He would go for drama and make it look like I planned it, some rape-murder-suicide thing."

"Charming man," she muttered. "Stupid, though. ISC would never buy it. I have augmented strength and reflexes. You would more likely end up dead than me."

"Even with the Promenade breaking?"

That made her think. "It would complicate things," she admitted. She motioned at the plateau. "If he's the one who turned on the Lions, those drones down there must be his."

"Drones?" Jato swore and started back up the steps.

Soz grabbed his arm. "There's nowhere to go that way."

He stopped, seeing her point. They couldn't go up, they couldn't go down, and the chasm waited beneath them. Now was the time to find out what arsenal, if any, they had at their disposal. "What else can you do besides see in the dark?"

"I've a computer node in my spine with a library of combat reflexes." She bent her arm at the elbow. "My skeleton and muscles are augmented by high-pressure hydraulics and powered by a microfusion reactor that delivers a few kilowatts. It gives me reflexes and strength two to three times greater than normal, as much as my body can sustain without overheating."

"Can you stop the globes?"

"Three or four, I could handle. But there are nine there." She looked down the stairs again. "They're coming."

He saw it now too, the Mandelbrot sparkle of globes revving into active mode. Their lights flowed upward in a fractal curve of luminance.

"Jato," a voice said.

He nearly jumped. The voice came out of empty air: cool, impersonal, commanding.

"Come down here," it said. "Bring the woman."

As Jato's adrenalin surge calmed, he realized it was only a globe transmitting the voice. "Go to hell, Crankenshaft."

"You have twenty seconds to resume descending," his tormentor said.

"Let her go and I'll do what you want," Jato said.

"Fifteen seconds."

The globes continued up the stairs, whirring like a swarm of huge bugs. Ten steps away, five, two. A syringe hissed, and Soz feinted with a speed that blurred, kicking up her leg. Her heel smashed into a globe, and it spun out from the cliff in a spiral of glittering lights.

A second globe rolled in to fill the gap, a third came from the side, a fourth whirred behind Soz, and a fifth hung over them, its syringe pointing down like the cannon on a miniature battlecruiser. Jato and Soz kept moving; feint, dodge, feint, Soz using her augmented speed. Two globes collided in midair with the grating racket of ceramoplex crashing together.

It was only a matter of seconds before a syringe shot hit Jato in the chest. The area went numb almost instantly and the sensation spread fast. As his arms dropped like stones to his sides, he lost his balance and tumbled down the stairs, stars and mountains careening past his vision.

He had one final glimpse of Soz lying on her back on the stairs, pinned down by globes, before his head hit stone.

* * *

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IV
Aurora

A high ceiling came into focus. After a while a thought surfaced in Jato's mind. He was alive.

He sat up, favoring his bruises. He was alone in Crankenshaft's studio. No, not alone. Soz lay on the other end of the ledge, eyes closed, her torso rising and falling with each breath. Relief rushed over him, followed by a Neanderthal impulse to go over, stake out his territory, and protect her from Crankenshaft. It wasn't the world's most logical response given she was an Imperial Messenger, but he had it just the same.

He wondered why she was still unconscious. Even his body contained nanomeds designed to repair and maintain it. An ISC officer probably carried molecule-sized laboratories.

As he got off the ledge, a clink sounded. Turning, he saw a chain with one end attached to a ring in the wall. Its other end fastened to a manacle around his ankle.

He gritted his teeth, wishing he could wrap the chain around Crankenshaft's neck. At least the tether was long enough to let him reach Soz. That almost made him back off; he trusted nothing Crankenshaft did. But his instincts were still at work, conjuring up *protect mate* impulses, so he went over to her.

Crankenshaft had no illusions about Soz needing protection. Her wrists were manacled behind her back and also to a ring in the ledge. He had set her boots on the floor and chained her ankles to the ledge. For some inexplicable reason, he also put metal bands around her neck and waist. Jato leaned over to lay his palm on her forehead—

Her hand clamped around his wrist so fast he barely saw her move. He froze, staring as she sat up. It hadn't been obvious from the way she had been lying, but the chain joining her manacles was broken.

He found his voice. "How did you get free?"

She dropped his hand, her face relaxing as she recognized him. "Nanochomps. I carry a few hundred species."

"You mean molecular disassemblers?"

"In my sweat."

He stepped back. He had no desire to have voracious bugs in her sweat take him apart atom by atom.

"They can't hurt you," Soz said. "Each chomper disassembles a specific material. The ones I carry are rigidly particular, even down to factory lot numbers."

He motioned at her manacled feet. "Wrong lot number?"

"Apparently so. Or else flaws in the molecular structure." Leaning over, she rubbed her wrist against the chain attached to his ankle.

"Hey." He jerked away his leg. "What are you doing?"

"They might work on yours."

"You don't think that's dangerous, carrying bugs in your body that take things apart?"

"They aren't bugs. They're just enzymes. And they're no more dangerous than being trapped here."

He knew it was probably true, but even so, he was having second thoughts about his amorous impulses. People sweated when they made love. A lot.

"Jato, don't look like that," she said. "The chompers are produced by nodules in my sweat glands that only activate when I go into combat mode. Besides, they can't take apart people. Our composition is too heterogeneous."

He sat on the ledge, near her but not too close, and motioned at his still-chained ankle. "Wrong lot, I guess."

"I guess so." She tugged the manacle on her wrist, managing to slide it up about a centimeter. The skin on her wrist was more elastic than normal tissue, not a lot, but enough so she could drag it out from under the manacle. He saw what she was after, a small round socket in her wrist.

"You have a hole," he said.

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"Six of them, actually. In my wrists, ankles, lower spine, and neck."

That explained the neck and waist bands. "What do they do?"

"Pick up signals." She held up her arm so the socket faced the console across the room. "If I insert a plug from that node into this socket, it links the computer web inside my body to the console."

That didn't sound like much help. "The plug is there and you're here."

"That's why consoles transmit infrared signals." Her face had a inwardly directed quality, as if she were running a canned routine to answer him while she focused her attention elsewhere. "The sockets act as IR receivers and transmitters. Bio-optic threads in my body carry signals to the computer node in my spine. It processes the data and either responds or contacts my brain. Bio-electrodes in my neurons translate its binary into thought: *1* makes the neuron fire and *0* does nothing. It works in reverse too, so I can 'talk' to my spinal node."

He suspected Nightingale was probably flooded with IR signals. "How can you stand so much noise hitting you all the time?"

"It doesn't. Only if I toggle RECEIVE." Her full attention came back to him. "The signals do get noisy and it isn't as secure as a physical link. But it's enough to let me interact with a node as close as the one over there."

"And?"

She made a frustrated noise. "This room ought to be bathed in public signals. But I'm getting nothing at all."

He doubted Crankenshaft would cut himself off from the city. "Maybe he did something to you."

"My diagnostics register no software viruses or tampering." She paused. "But you know, my internal web is engineered in part from my own DNA. Maybe he infected it with a biological virus." Without another word, she lifted her wrist and spit into its socket.

Dryly Jato said, "Insulting it won't help."

She smiled. "The nanomeds in my saliva may be able to make antibodies if there's a virus loose in my biomech web."

"Are you getting anything?"

"Nothing." Several moments later she said, "Yes. A notice about a ballet." Her concentration had turned inward again. "I still can't link to the city system . . . but I think I can get into the node in that console over there."

Jato stared at her. "Not a chance. That's Crankenshaft's private node. Everyone knows his security is unbreakable."

A cold smile touched her lips. "Security is my game."

A moment later she said, "I can call up his holosculpture of you if you want."

Jato swallowed. She might as well have hit him with that ancient proverbial ton of bricks. "Yes. I want."

She indicated the center of the studio. "That's it."

He turned—and almost gasped.

The air above the pool was glowing with a rainbow-hued mist. It drifted across the glistening white cones that stood in the water, like shadows made on outcroppings of rock by clouds obscuring a sun. This, from a man who had lived his entire life in the night. Holos of Jato appeared on every cone. On the tallest, the one with the circular cross-section, he sat with knees to his chest, shivering, his clothes and hair dripping. He was younger, eight years younger, only a husky teenager. His face cycled through emotions: rage, confusion, resentment.

An older Jato stood on the next cone, the one with its top cut off at a slant, giving it an elliptical cross-section. He remembered when he had modelled for it, how he stood for hours on a narrow shelf protruding from the surface. Crankenshaft had since removed the shelf and erased it in the image, so the Jato holo simply floated in the air, with

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red and blue clouds scudding across his face. He was shouting, fists clenched at his sides. No sound: just his mouth moving. With the play of light, it was hard to make out words, but he knew what they were. He had been cursing Crankenshaft in his native tongue.

The Jato by the parabolic cone was sitting, submerged to his hips in the pool. He trailed his hands back and forth in the water, a habit he had developed to cope with the boredom. He was kneeling by the hyperbolic cone, up to his waist in water. Crankenshaft had doctored the holo to make him look old. Ancient. His face was a map of age untouched by the biosculpting the rich used to sustain youth during their prolonged lives. Gusts blew brittle white hair around his head. Stooped, gnarled, decrepit: it was a portrait of his mortality.

That tableau remained frozen for a few seconds. Then all the Jatos stood up and began stepping from cone to cone, passing through each other while multicolored clouds flowed across their bodies. Some raged, others shivered, others moved like machines.

Each figure split, becoming two Jatos, all continuing their strange march. They split again, the original of each quartet stepping from cone to cone while the others kept pace in the air. New images appeared like shadows, all different by just a small amount, creating a feathered effect. A younger one was crying. He remembered that day; he had told Crankenshaft about his family, how he loved them, how they must think he had died. Another Jato image was laughing. *Laughing.* Yet there were times he had laughed—even had civil conversations with Crankenshaft.

Holos of water augmented the pool, overlaid on the real water like multiple exposures: waves in impossibly sharp points, or serrated like a saw, glowing phosphorescence in red, purple, green, blue-green, gold, and silver. Gusts in the studio whipped the true water into peaks that added random accents to the holos.

The Jatos split again, along with their shadows. They all stopped and raised their hands, the motion feathered among the images, as if it portrayed multiple quantum universes, each projecting a future that diverged from the original. The image of a rainbow-hued waterfall sprayed over the figures, making them shimmer. But no blurring could hide the fury on those faces.

"Saints almighty," Soz said. "It's spectacular."

Jato tried not to grit his teeth. "That's why he's so famous."

"I can see why he wanted you for his model."

"You can?"

She motioned at the holos. "You couldn't get that purity of emotion—that fury—from a Dreamer. From most anyone. But from you, it's perfect. Pure passion unadulterated by civilization."

"Am I supposed to be flattered by that?"

Soz winced. "I didn't mean—" She stopped, staring at the sculpture. "Jato, look at your eyes."

"That would be a feat." But he knew what she meant. He studied the images—and when he saw it, he nearly choked. Crimson. Ruby hard and ruby cold. The eyes on each image had turned red. The hair was changing too, going from dark brown to crystalline black. He couldn't believe it. Crankenshaft was making *him* look like a Trader.

He stood up, his fists clenching at his sides. "I'll kill him."

"It's guilt," Soz said. "And catharsis."

"What the hell does that mean?"

"It's all there," she said. "The guilt the Dreamers feel, knowing the brutality their disowned kin have inflicted on a thousand peoples. And catharsis. Realizing the monster isn't in them anymore. They've freed themselves, become Dreamers instead of Traders."

"Then it's a *lie*." Jato was so angry he could barely get the words out. "For this

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'catharsis,' Crankenshaft made himself into the very thing this is supposed to free him from. He's made me look like what he hates in himself, what he can never get rid—" Jato stopped cold. Then he sat down again. "Oh, hell."

Soz was watching his face. "What?"

"His greatest work. Face his demons and exorcise them. I'm the substrate." It was suddenly all too obvious. "Get rid of me and he loses his inner devils." Jato swallowed. "He's going to kill me as part of the sculpture. It's what he's always intended."

She stared at him. "That's sick."

Jato wished he had never pulled her into this. "If we had died on the Promenade, he would have worked with that footage. Now you're onto him, so he has nothing to lose by bringing us here where he can tailor the work to his needs."

"Actually," a voice said. "You're the one who is going to kill her."

He looked up with a jerk. Crankenshaft was standing across the studio, by the console in the corner where the two holo-walls met. In one hand he held Jato's bird sculpture; in the other, he had a laser carbine.

"A tragedy," Crankenshaft continued, in the voice he used when he wanted to bait Jato, to drive his rage. "She came to the greatest artist alive hoping to inspire a dream. A beautiful woman, after all, has certain advantages. Unfortunately she arrived while you were here." He sighed. "I should never have left you two alone. But who would have thought an Imperial Messenger would be in danger? Besides, Jato, we thought we had cured you." He shook his head. "She was overconfident. An unguarded moment and you were able to bind her." Lifting the bird, he said, "A blunt instrument you stole from me brought about her death. I was forced to kill you in self-defense."

Jato stood up, an explosion working up inside of him. But before it let loose, Soz spoke in a mild voice. "You're Granite Crankenshaft."

Unease showed on their captor's face. "You should have never pried into his records, Messenger."

"Why would you claim Jato stole that bird from you?" she asked. "He made it."

The tic under Crankenshaft's eye gave a violent twitch. He shifted the sculpture, his hand gripped around it as if he held a weapon. "No one would ever believe he created a work as stunning as this, with that fugue. Only his exposure to me enabled him to do it. Me. He could never have done it by himself. So the credit belongs to me."

Jato knew he should be infuriated that Crankenshaft would claim credit for his work. But the implication in his captor's words so staggered him that the arrogance of the statement rolled off his back. He could hardly believe it. The great Granite Crankenshaft was threatened by *his* work.

Crankenshaft unhooked a cord from his belt and threw it at them. It landed at Jato's feet, a leather thong with ceramoplex balls on each end that could have been anything from decorations to superconducting webs.

"Tie her hands behind her back," Crankenshaft said.

Jato crossed his arms. "No."

Crankenshaft touched a panel on the console. A giant globe crept through a slit in the thermoplastic wall and floated to the center of the studio.

"Non-linear dynamics and metapsychology," he commented. "Do you know that with detailed enough initial conditions, you can model procreation? The correlation between the calculated results and an actual act that proceeded from those conditions is quite high."

Jato scowled. "What are you talking about?"

"Sex," he said. "Establish the initial scene well enough and you can model the rest with amazing accuracy."

"Go to hell," Jato said.

"Tie her hands."

"No."

"Commence protocol," he said.

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Three syringe guns slid out of the globe. Jato didn't duck fast enough, but it didn't matter: none of the shots were aimed at him. Soz moved in a blur, but she couldn't go anywhere with her ankles chained to the ledge. One shot missed her, but judged from her reaction, the other two hit home. She jerked as if she had been struck and her entire body tensed.

"What are you doing?" Jato shouted at Crankenshaft.

"Jato, it's all right," Soz said. "I'm fine."

"It's a clockwork venom," Crankenshaft told her. "Even your meds can't adapt enough to deal with it."

She said nothing, just focused her attention on him with an unsettling intensity.

"What's a clockwork venom?" Jato asked.

Soz glanced at him. "The name comes from clock reactions." Although she sounded cool, sweat was beading at her temple. "Combine certain chemicals under proper conditions and they cycle through a series of reactions. In human blood, clockwork venoms undergo a cycle, each step producing a different poison."

"Can your nanomeds fight it?" Jato asked.

Crankenshaft answered. "Even sophisticated meds have trouble with complicated cycles. This one has hundreds of steps, all with varying duration lengths and side reactions that change from cycle to cycle. It's a brilliant work of chemistry." He gave Jato an appraising look. "You've felt one poison in the cycle. Last time you were here. Perhaps you recall?"

Jato remembered all right. It had burned like hell.

"The others have different effects," Crankenshaft observed, as if Soz were a lab experiment. "Nausea, muscle stiffness, dizziness, pain. She'll start vomiting soon. Eventually she will die."

Soz remained calm, but sweat was running down her temples. When she wiped at it, the motion looked mechanical, as if she had let the hydraulics in her body take over.

"As soon as her hands are bound," Crankenshaft said, "I'll give her the antidote."

"Jato." She spoke quietly. "Do what he says. Please."

There was no mistaking the strain in her voice. Jato grabbed the thong off the floor and wrapped it around her wrists. The broken lock mechanism on her manacles felt warm, probably from the energy released when her chompers ate it. He tied the thong loosely around her wrists, making no attempt to knot it. But the ceramoplex balls activated and yanked the cords tight, binding her wrists and then locking into each other.

"Leather," Crankenshaft said.

Jato straightened up. "What?"

"In molecular terms, it's complex," he said. "More heterogeneous than, say, manacles. Not as strong, but a logical backup when dealing with disassemblers."

Jato gritted his teeth. How did Soz stay so cool? She just watched Crankenshaft, intent and quiet. Crankenshaft took a ring with two mag-keys off his belt and threw it to them. As the keys hit the floor near Jato's foot, a syringe on the globe hissed. Soz moved like an automaton, trying to duck, but the shot hit her anyway.

"That had better be the antidotes," Jato said.

"The red key unlocks your ankles," Crankenshaft said. "Gold unlocks hers."

After Jato freed their ankles, Soz moved stiffly, swinging her legs off the ledge.

"Go to the pool," Crankenshaft said. "Both of you."

"No," Jato said.

"Don't make it harder on her than necessary," Crankenshaft said. "I can calculate a lot of what I need, but I'll achieve better results with genuine images of the two of you to work from."

Jato stayed put. "I won't rape her and

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I won't kill her. You can doctor holos to make me look like a Trader, but nothing can make me act like one."

Crankenshaft's voice hardened. "Go to the pool. Otherwise, I'll pump her so full of clockwork venom she'll beg you to kill her."

With no warning, Soz moved. *Fast.* Dropping to one knee by her boots, she whipped out her hands, shreds of leather flying away from her wrists. She yanked the "decorative" tubes off her boots and brought them up, one in each hand, liquid shooting out from both. One stream splattered over the drone, creating clouds of gas. The other hit Crankenshaft's carbine and splashed into his face. He shouted, dropping the laser as he covered his face with his hands. When the gun hit the ground, it shattered like porcelain.

The Mandelbrot globe hissed and a shot from its air-syringe hit Jato in the neck. In a bizarre blur of motion, Soz threw her boots. They hurtled through the air and smashed into the globe, shattering its outer shell where the liquid from her cylinder had doused it. The whole assembly crashed to the floor, its innards breaking apart on the stone. Blinking and humming, the debris moved in twitches as it began to reassemble itself.

"Smash the components!" Soz yelled, sprinting across the studio. She moved like a puppet, her body under control of hydraulics rather than muscles and bones.

As Jato strode over to crush the remains of the drone, he saw Crankenshaft lower his hands, revealing a face covered with burns. In the same instant that he grabbed for a gun on his belt, Soz reached him. She brought her hands up with eerie speed and hit him under the chin, snapping back his head. He flew over backward, crashing to the ground. His head hit the floor and he lay still, breathing but unconscious.

"Soz, no!" Jato raced forward when she jerked up her leg. He collided with her as her foot came down, and they staggered to the side, enough to make her miss Crankenshaft. Her foot hit the floor with a teeth-jarring impact that would have crushed the Dreamer's chest.

Jato gulped in a breath. "No killing."

She turned to him like a machine, no emotion on her face. It was hard to believe this was the same woman he had kissed on the Promenade.

Then her expression became human again, as if she had reset herself. She exhaled. "He'll live." Grimly she added, "We might not. Are you all right?"

A familiar burning was spreading in his neck and torso. "I took a shot of venom. Did he give you an antidote?"

"No. More venom." She went to retrieve her boots and their tubes. "My meds are trying to synthesize an antidote, but it's hard to do when their target keeps changing."

"We better hurry." He grabbed his bird off the console. "His node must have alerted the city and his other drones."

She pulled on her boots. "I put locks on his system. It will take a few minutes for it to break them." Her voice sounded strained. Labored.

As Jato turned toward the door across the room, his gaze raked the pool—and he froze.

The holosculpture was still evolving. It had spawned more and yet more Jatos, until they blended into a design of feathered motion. A superimage had formed, a fractal, its pattern repeating on a finer and finer scale. Superimposed on the fractal, a face was coming clear. A giant Trader face.

His face.

"*No.*" He spun back to the console.

"Come on!" Soz called.

He stabbed at the console. "We have to destroy that sculpture."

"We have to go! We don't have much time."

"He stole my *life*." Jato gave up on the computer and swung around to her. "He

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created a mirror of himself, but he put it on me. It's like—like—" He slammed his palm against the console. "He's a thief. Of my soul." He pointed at the sculpture. "That's me. No matter where I go or what I do, as long as that exists he owns me."

Sweat was dripping down her face. "I can't guarantee I'll find all his backups."

"If anyone can, it's you." He clenched his fists. "He owes me. And for him, losing his 'masterpiece' will be a punishment worse than dying."

Soz strode to the console and went to work, making hieroglyphics ripple across its panels in garish displays. She didn't waste time pulling out her wrist socket; instead, she hauled off her boot and set her foot on the console, showing no strain with the contorted position as she plugged a prong from the console into her ankle socket.

Seconds passed.

Longer.

Waiting.

"Got it!" Soz jerked out the prong. "Downloaded one copy into my internal memory for you. Erased everything else." She yanked on her boot. "Now let's go."

They ran across the studio to the cliff door. As they stepped outside, into the blasting wind, she stared down the stairs. "No rail."

Jato struggled to keep his balance, fighting the gales and his venom-induced dizziness. "I'll go first. If I fall, I won't hit you. You're light enough so if you fall you probably won't knock me off."

"All right." Her voice sounded thick.

He had expected her to insist on going first. His gut reaction ignored the obvious; she was part computer and machines worked on logic rather than heroics.

Clutching his statue, he started down the stairs. An abyss of air and rushing wind surrounded them, turbulent, violent. Step. Step again. He took it slow, halting when waves of dizziness hit.

Step.

Step again.

Scrapes came from above and he jerked his head up to see Soz lose her footing. Lunging for her, he lost his own balance and stumbled on the step, teetering over the void. Lurching back, he reeled to the step's inner edge, where he fell to one knee and found himself staring down the shaft of air in the center of the spiral.

"Jato?" Soz rasped.

He took a breath, looking up to see her kneeling on the step above him.

"You all right?" he asked. She nodded and they got up, then continued their descent.

The wind was probably cold, but with the fever burning in his body he couldn't tell. He moved in a haze of nausea and dizziness.

Step.

Step again.

Step—

No step. He looked down. They had reached the bottom.

Soz made a strangled sound and sagged against his back, grabbing him around the waist with both arms to keep from falling. Turning, he put his arm around her for support.

They walked around Nightingale, far enough outside the city to let darkness cloak them. His legs strained to run but he held back, not only because his poisoned body couldn't keep such a pace but also because it would draw attention. A couple strolling arm-in-arm along a romantic path was one thing; two people running was another.

He motioned at the tubes on her boots. "What's in those things?"

"Liquid nitrogen." She sounded hoarse. "With disassemblers to boost its effect. It freezes what it hits and the chompers eat it. They're less specialized than the ones in my body, which makes them more dangerous, but they dissolve after exposure to air."

"How did you free your hands? Do the chompers in your sweat eat leather after all?"

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"No." She grimaced. "Mine are far too specific. Anything general enough to take apart a material as heterogenous as animal hide would probably take apart our hides too." She showed him the broken chain on her manacle. "Feel."

He ran his finger along the jagged edge. "It's sharp."

"So was the part on the ledge. I rubbed the thong against it until it cut the leather."

"No tech that time," he said. "Just brains."

She smiled wanly. Sweat soaked her collar and she walked stiffly, her legs controlled by the hydraulics inside her body.

The starport was so small it had no terminals, just a gate at the airfield entrance. As they neared it, two Mandelbrot globes rolled out to intercept them. Jato tried to dodge, but the one headed for him easily compensated for his evasive actions. It slammed him in the chest and he stumbled backward, then recovered and sprinted to the side. As the globe followed, he doubled back to run around it. The ploy worked with Crankenshaft's drones on days he programmed them for slower responses, to make the chase "entertaining." Jato doubted this one belonged to Crankenshaft, though; after what had happened, his would go for the kill.

This globe caught him—and rammed his head. As he fell, patches of light punctuated his vision and loud noises buzzed in his ears. With his statue cradled against his chest, he hit the ground and groaned. As he rolled away from the whirring demon, he caught a glimpse of the aircontrol tower. Lights were coming on inside it.

They had run out of time.

Then Soz said, "Eat it, fractal."

A stream of liquid arched into view, bathing the drone in a shower of glistening drops. The globe reoriented on Soz like a giant ceramoplex balloon. As it went after her, she tried to feint, but she lost her balance and fell to her knees. When the globe swooped in on her head, she jerked to the side. It hit her shoulder—and shattered, raining Mandelbrot innards all over her body. In seconds, she was kneeling in the midst of junk large and small, from both globes, lights blinking and components humming.

Soz and Jato stared at each other. Then they scrambled to their feet and sprinted for the airfield. Alarms were blaring, coming from the distant airtower and speakers along the field's perimeter. As they ran through the gate, which was no more than a few bars that swung to one side, Jato saw a Jag starfighter out on the tarmac. It gleamed like alabaster, as much a work of art as any sculpture.

When they reached the Jag, its hatch dilated like a high-speed holocam. As soon as they lunged through the opening, it snapped closed. A membrane irised in the nose of the ship, revealing a cockpit. As Soz squeezed into the pilot's seat, it folded an exoskeleton of controls around her like a silver-mesh glove. Jato stood behind her chair, hanging on to its back while his nausea surged.

"Neck and lower spinal nodes blocked," an androgynous voice said.

"Ankles," Soz said, intent on her controls.

While her hands flew over her forward controls, a robot claw pulled off her boots and a mesh enfolded her feet, plugging into her ankle sockets. After that Jato heard nothing; the ship was communicating directly with her internal systems.

Suddenly Soz spun around her chair and pulled down Jato's head. He fell forward, grabbing the arms of her seat to catch himself. She kissed him hard, pushing her tongue into his mouth.

He jerked away. "Are you craz—"

"I'm giving you the antidote. In my saliva. My web figured it out and my meds made it." She pulled him back into the kiss.

So he kissed her, while guns boomed

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from the port defenses and the ship shook. Although the Nightingale port claimed only a small arsenal, it could still do damage. He just hoped the Jag could protect itself while its pilot and her passenger took their medicine.

Then Soz pulled away from him and smiled. The cockpit elongated and a second chair rose from the deck. "Co-pilot's seat," she said. "You take."

He slid into the seat, and a slender probe from it extended to his ear—in time for him to hear a voice shout, "Skyhammer-36, acknowledge!"

He nearly jumped out of the chair. Then he realized he was hearing Soz's communications with the aircontrol tower.

"You are not cleared for take-off!" the voice said. "I repeat, you are not cleared for take-off."

"Tough," Soz said. Then she fired the rockets.

Jato knew a stealth craft like the Jag could come and go with barely a whisper—if that was what its pilot wanted. They took off in a thundering roar of rockets. For her parting salute to Nightingale, Soz blasted the holy hell out of that tarmac.

As acceleration pushed them into the seats, a holomap came on, showing Nightingale receding into the spectacular bones of the Giant's Skeleton Mountains. The peaks withdrew until they were no more than wrinkles in the vast panorama of the world.

Gradually Jato's mind absorbed the situation. He was free. *Free.*

Or at least, he thought he was free. "What happens now?" he asked.

Soz glanced at him. "I'll take you to headquarters. You can clear your name." She hesitated, a blush on her cheeks. "I can help out, if—if you would like."

Her uncertainty floored him. He had seen her face death by Promenade collapse, clockwork venom, and snuff-art, all with remarkable composure. Yet asking if he wanted her to stick around made her nervous.

He smiled. "Yes. I would like that."

Her face gentled. She glanced at the statue he still held. "I felt what it took for you to offer your sculpture to me. Thank you."

"It's not much."

"It's spectacular, Jato. Both the bird and the fugue."

He swallowed, at a loss how to tell her how much her words meant. So instead he motioned at her holo display. "Soz, look."

Together they watched the sun rise over the rim of Ansatz.■

This novella is set in the same universe as Catherine Asaro's Skolian Empire books. The character Soz in this story is also a main character in the novel The Radiant Seas, *which came out this month from Tor books, and is the narrator of a previous novel* Primary Inversion. *"Aurora in Four Voices" takes place about sixteen years prior to* Primary Inversion.

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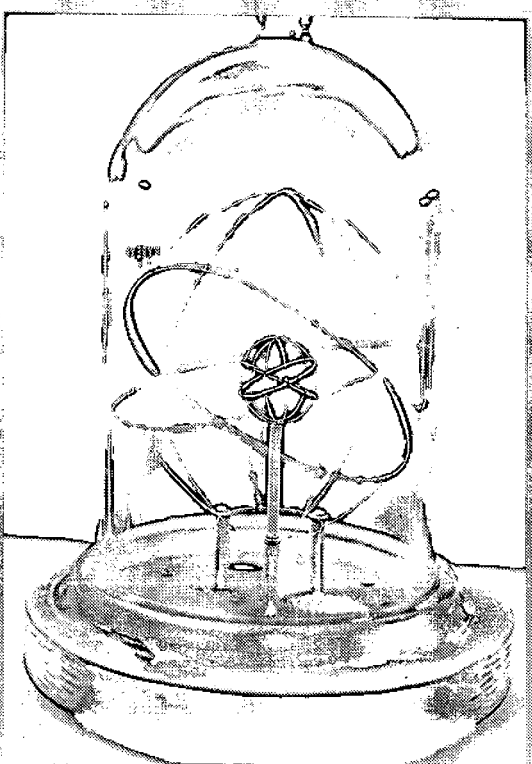
Tom Ligon

THE WORLD'S SIMPLEST FUSION REACTOR

And How to Make it Work



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A really distressing trend has been developing for some time among science fiction fans I've met. A lot of you are growing quite pessimistic about the prospects for practical fusion power in general, and fusion-powered space travel in particular. The roots of this disillusionment are not hard to find.

Fusion, for those of you who slept through high-school physics, is the process of squashing two atomic nuclei together to produce a new element. Many lightweight nuclei give off copious energy when this happens. In the Sun, hydrogen nuclei fuse (through a complex cycle involving carbon, nitrogen, and oxygen) to form helium. The process occurs deep in the Sun's core, at mind-boggling temperatures that cause the nuclei to move rapidly, where similarly mind-boggling pressure keeps the nuclei in close proximity, and sheer bulk prevents rapid heat escape. The physics community often calls these "thermonuclear reactions" because of the high temperatures driving them in the Sun, or triggering them in "hydrogen" bombs.

When I was studying Health Physics in the mid-seventies, the nation was well into a program to develop "practical, clean thermonuclear fusion power." This was universally acknowledged to be a considerable technical challenge, but we were told to expect results in, say, twenty-five to thirty years. Well, twenty-plus years have come and gone, along with twelve billion fusion research dollars (over the past 45 years), and those researchers have announced that they have made a great deal of progress. They say if we will only fork over the money (another ten to twelve billion) for the next stage of R&D, they think they might be able to build a net power demonstration reactor in another twenty years. This should lead to a workable fusion powerplant in about forty or fifty years, for *another* $25 billion. Present indications are that the resulting powerplant would not be able to run competitively with any current powerplant technology.

The focus of most of the present Department of Energy (DOE) research is large tokamaks. How large? The next generation of research machine planned, with the supporting equipment and structure, will be about the volume and mass of an aircraft carrier. It is expected to use gigantic toroidal superconducting magnets, storing magnetic energy equivalent to 1/40 of a Hiroshima bomb, which would be released suddenly if the liquid helium cooling system were ever breached and any one of the magnets warmed above the critical superconducting temperature. Surrounding the machine is a blanket of molten lithium one to two meters thick. The core of the machine is a torus (donut) sixteen meters high and twenty-two meters across with a cross-section diameter of five meters, filled with a stupefyingly potent confined plasma, whose structural material will become radioactive as the machine runs. This beast might actually hit breakeven occasionally (i.e produce as much power as it consumes), with a little luck. Presuming working power plants would be even larger and heavier, the system does *not* look promising for strapping on the back of a rocket!

Additional work continues on laser- and particle beam-fired fusion. The reaction vessels proposed for this program are considerably smaller, however the lasers or beam guns and power systems to run them are even larger and more massive than those of the tokamaks, making them prohibitive for space propulsion use.

Both systems struggle to overcome the three competing factors which have so far made thermonuclear fusion such a formidable challenge. The goal is to slam fuel nuclei together hard enough to make them stick and form new elements. Nuclei carry a positive charge, and like charges repel, and they do so more vigor-

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ously the closer they approach. This "Coulomb barrier" is the force which must be overcome to cause fusion. To make a useful power reactor, you must have particle velocity, density, and confinement time sufficient to produce enough reactions to generate more power than is required to drive the reaction.

Tokamaks use magnetic confinement, and inject energy into the confined plasma (typically by huge current discharges or bursts of microwave energy) to heat the plasma to temperatures which raise the velocity of the nuclei to overcome the Coulomb barrier. The powerful magnets surrounding the reactor force the plasma ions (ions are atoms missing some or all of their electrons) to follow tight circular paths within the machine, isolating the plasma from the walls and giving high confinement time, thus opportunity to react. However, there are practical limits to magnetic field strength, and those limits are felt most severely under the conditions where trapping is most needed. Fast-moving ions needed to cause fusion make larger orbits than slower, cooler ions, and thus temperature and density are in constant conflict. There is also an inherent stability problem in these machines: when ions collide *without* causing fusion (which is most collisions in a thermal system), they tend to "jump to new field lines." Just a few collisions will likely make them jump to the wall of the machine. The net result is that while large tokamaks using superconducting magnets placed outside the torus and lithium blanket can confine hot ions for long times at low density, or cold ions for long times at higher density, you must build very large machines in order to achieve sufficiently high temperature (high ion velocity) and high density at the same time.

Laser- and particle beam-fired approaches (called Inertial Confinement Fusion, or ICF) use small pellets or capsules of fusion fuel flash-heated by extremely powerful lasers or particle beam pulses. The fuel is usually liquid or even solid, so initial density is fairly high, although this system requires the fuel to be compressed to a far higher density in order to react. The capsule is not just a fuel container; it serves to absorb the laser or beam energy, compress the fuel as the capsule explodes, and provide mass (and inertia) to confine the heated fuel long enough to react. The challenges in ICF stem from the fact that high temperature causes rapid expansion of the capsule and fuel: temperature and confinement time are in conflict. ICF machines also have their own instability problem: once you compress the fuel pellet to a small fraction of its normal size, it will find any little gap in what you are compressing it with, and try to squirt out. So far these problems have frustrated attempts to produce useful ICF fusion.

Both of these methods have achieved some limited success; that is, they have produced fusion, far below breakeven. However, both use heat as the means of raising the velocity of the ions, what physicists call "Maxwellian" (randomly oriented and distributed) velocity. Stephen L. Gillett would use the term "Promethean"[1], for Prometheus, the bringer of fire. Both approaches rely on the principle that a heated plasma contains a wide distribution of particle velocities. "Temperature," in the sense of gas and plasma physics, is the average kinetic energy of the particles involved, and kinetic energy is proportional to particle mass and the square of the velocity.

The trouble is, neither approach brings the *average* ion kinetic energy up high enough to cause fusion. Only the fastest few percent of ions reach the energy needed to overcome the mutual repulsion of the Coulomb barrier. Furthermore, the heated ions move randomly in all directions, thus collisions are at random angles which usually do not produce fusion. What they need is particles hitting head-on at fusion energies; but what goes on in thermal systems, at the

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particle level, is virtually uncontrolled chaos: fast and slow particles colliding like bumper cars at all angles.

Finally, while these heat-based methods *do* produce *some* fusion, they do so *only* with the easiest of fuels: deuterium ("heavy hydrogen," with a nucleus of one proton and one neutron), tritium (one proton with two neutrons), and helium-3 (two protons and one neutron). Thermonuclear fusion has been pushed on the public as "clean," i.e. not producing nuclear waste. This turns out not to be quite the case. Reactions between two deuterium nuclei (DD), or deuterium and tritium (DT) produce neutrons. Most of the useable energy in the favored DT systems comes from the neutrons, and the only way to exploit it is to slow them down in a blanket of absorbing fluid (usually liquid lithium) which is then used to make steam to run a turbine (more Promethean technology). In fact, the DT systems *depend* on neutrons reacting with the lithium to produce more tritium fuel, for tritium is a fast-decaying radioactive isotope not found in nature. The neutron-lithium reaction also breeds helium-3.

From time to time you may hear about this miraculous nuclear fuel, helium-3, which supposedly can be mined from the lunar surface (actually, the Jovian atmosphere is probably a *far* better source). The claim often heard is that the reaction between deuterium and helium-3 produces no neutrons. While this is true, any such reactor will also produce deuterium-deuterium reactions, which *will* produce neutrons. While it is a substantial improvement over tritium, it is far from aneutronic. If a DT reactor could kill you in one second, a DHe^3 reactor would require about *thirty* seconds to kill you. Besides, as mentioned above, that lithium blanket has a purpose: it reacts with the neutrons to produce tritium and helium-3! The aneutronic reaction can't breed its own fuel, but the neutron-producers can.

While the neutrons produced by these reactions can be harnessed to make heat and more fuel, they have very undesirable side effects. They render many engineering materials radioactive, transmute their elements, and produce metallurgical damage. Thus, after a few years of operation, the inside of the reactor becomes weakened and possibly even deformed. Repairs and disposal of the damaged material are greatly complicated because it is radioactive.

Fusion the Easy Way—Using Vacuum Tube Technology

There are a variety of other potential fusion fuels for which the necessary temperatures for fusion are simply too high to be achieved by the *thermonuclear* technologies DOE is currently pursuing. How do we know about these reactions? We have been doing them since 1928, using extremely simple devices called linear accelerators[2]. Charged particles can be made to accelerate to enormous velocities and energies by means of simple electric fields. By charging a grid to a few hundred thousand volts, you can accelerate protons or other light nuclei fast enough to fuse with almost any element in the periodic table. True, it takes far more energy to run such a device than it produces, but the equipment is extremely simple, and the "temperatures" achieved are easily sufficient to produce most transmutation reactions between nuclei.

Let's bury this "temperature" nonsense right here and now. While you may have heard a figure of something like fifty or a hundred million degrees being required to produce fusion, in fact few researchers use those numbers except to impress the public. The units of temperature they use are "electron volts," which are easily understood in terms of linear accelerator operation. For every electron's worth of charge on a particle, multiply by the volts on the accelerating grid to get electron-volts of energy. For purposes of impressing your friends, for each electron volt, multiply

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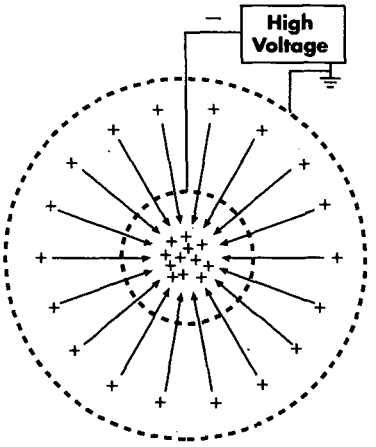
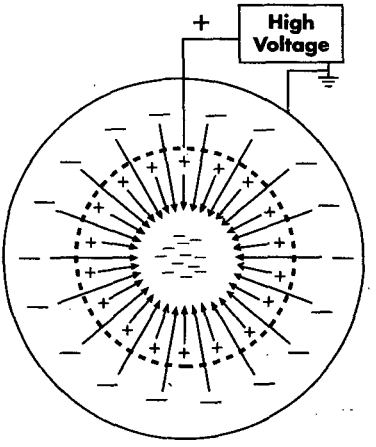
Fig. 1. The two basic spherical convergence methods



IXL configuration. Negative inner grid attracts IONS(+)



EXL configuration. Positive inner grid attracts ELECTRONS(-). Electons converging in center attract IONS(-) formed inside inner grid.

by 11,604 to get degrees Kelvin. You may be amused to know the electrons hitting the screen of the typical television set are around 200 million degrees according to this scheme, and 50 million degrees is a paltry 4300 electron volts.

At about the same time linear accelerators were first being developed, development of vacuum tubes, or electron valves, was being refined. Vacuum tubes use the principle that a very hot metal surface will emit a cloud of electrons, which can be caused to cross a gap in a vacuum to a positively charged "anode." In simple diode vacuum tubes, a hot tungsten filament or heated thin cylindrical surface (the "cathode") is surrounded by a cylindrical anode (also called the "plate") and electrons will flow from cathode to the anode, but not from the anode to the cathode.

One of the best-known researchers in the field was Irving Langmuir, who had developed theories and confirmed by experiments the principles of "space charge limitation" between tube elements composed of concentric cylinders. In 1924, Langmuir and Katharine Blodgett[3] investigated the case of concentric *spheres* as a vacuum tube configuration. While the device worked well, the normal configuration was concentric cylinders, which were much easier to manufacture and also worked well, so there was no widespread use made of this development at the time. Limited use of the spherical configuration includes some "multipactor" tubes and certain specialized light sources.

In the mid-1950's, P. T. Farnsworth (one of the inventors of television) pondered the bright visible convergent focus glow that forms in the center of spherical multipactor tubes, and came up with the idea of using a spherical diode with the inner electrode in the form of a highly transparent wire grid (i.e. a very open mesh screen) as a fusion machine. Called the "Fusor," the device, later patented[4], would cause ions of fusion fuel to speed to the center of the machine. As they converged on the

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central focus region, their density would increase rapidly, making collisions more likely. Ions which did not collide would decelerate out the other side, stop, and accelerate back to the center for another try, conserving energy. The class of machines based on this principle are "spherical convergent focus electrostatic ion accelerators," with the abbreviation IXL to remind us that they use the grids to accelerate *ions* (see figure 1). Because they use simple electrostatic forces to accelerate and confine ions, and rely on the inertia of the ions to store energy for collisions, the term Inertial Electrostatic Confinement (IEC) is used for machines of this type. Be careful not to confuse it with ICF, or laser/particle beam fusion.

By 1959, Elmore, Tuck, and Watson[5] explored the idea of using Farnsworth's gizmo backwards to accelerate *electrons* from the outer sphere (a cathode) to the inner sphere (an anode). The inner sphere of such a machine is a grid, which forms a geodesic "potential surface" which the electrons aim for as if it were solid. However, when they get there, most pass right through and coast in a straight line, converging from all sides to the center, then they pass out the other side. What results is a region at the center of the inner sphere with a very high density of negative charge, called a "virtual cathode." This region will attract positively-charged ions, which will tend to oscillate back and forth through the central region. Provided more electrons are force-fed into the system than ions, a "potential well" is formed in which the ions are trapped by excess negative charge. Interestingly, an ion oscillating entirely inside the inner grid will be trapped almost indefinitely, thus theory predicted this device might be a surprisingly efficient ion trap. However, the electrons had to pass through the grid, which meant eventually most of them would *hit* the grid. Depending on the grid's "transparency," an electron might make 10 to 50 passes before being lost, requiring another electron and the power to fire it into the system. Because the electrons had to outnumber the ions by a significant margin, the researchers expected this device could be harnessed to produce only tiny amounts of fusion, and decided it could never make a workable power reactor. The Elmore, Tuck, Watson concept is an electron accelerator, or EXL machine (see figure 1).

In 1967, Robert L. Hirsch published a paper describing a concentric sphere device which produced "copious neutron emission"[6]. Hirsch (working at the ITT/Farnsworth Lab under Farnsworth's enthusiastic encouragement) used the IXL configuration, with the cathode (negative grid) in the center and the anode (positive) to the outside. His machine was a spherical version of a linear accelerator: positive ions formed at the anode accelerated toward the central cathode grid (the opposite of the behavior of electrons, which are negatively charged). Again, the accelerated particles usually miss the inner grid, continuing on to the center of the device. There they stood a fair chance of collision, and very importantly, all of the particles were *at the same energy*, which was sufficiently high for fusion to occur. If they missed or collided without producing fusion, they could travel out the other side, conserving their energy for another pass through the middle. Although not all collisions were head-on, particles which did not fuse rebounded with most of their original energy. It did not matter to which direction they rebounded, as all directions were "uphill" against the potential gradient, so they slowed down, and came rushing back "downhill" for another try. Like the Elmore, Tuck, Watson design, the losses due to grid collisions prevented breakeven, but a lot of fusion was possible, nonetheless.

Dr. Hirsch operated his machine at up to -150,000 volts on the inner grid, at currents up to 60 milliamps. Using DD

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and DT, the machine produced abundant fusion, but far below breakeven. The neutron emissions he achieved (published results on the order of a billion neutrons per second, and unpublished results of around a *trillion* per second!) would be considered dangerous today. Hirsch also built an Elmore-Tuck-Watson EXL machine, and verified it would produce a deep potential well.

What Hirsch's machine demonstrated was that, contrary to popular belief, fusion is actually quite easy to produce, once the *thermo* mindset is shed. The problem is to come up with a configuration that does not waste the drive energy.

The Nuclear Reactor
High-School Science Project

I notice a few of you have gone glassy-eyed on me. Trust me, this is *easy*. A Farnsworth-Hirsch machine is so simple it could be built as a high-school science project (though I caution that **a knowledgeable advisor should be sought, and good safety practices must be followed**). You will need to borrow, buy, or build some vacuum equipment, obtain a small supply of deuterium, and figure out some instruments so you can tell if it is working, but the actual reactor components are *trivially* simple to build, and will cost only a few cents!

WARNING

The apparatus described in this article uses high voltages at potentially lethal currents. High vacuum apparatus and compressed gasses may also be dangerous if improperly used. This device may produce ultraviolet radiation and soft x-rays. Do not attempt to build or operate such a device unless you have been trained in high voltage safety, and safe use of compressed gas cylinders and vacuum equipment, and can verify that no unsafe radiation exposure occurs.

Regarding the presumed danger of building a nuclear reactor, the simple fact is that the proposed machine would run at the very bottom end of the voltage required for fusion, and it will take some skill and effort to even detect the neutron output. The *real* danger is in the potentially lethal high voltages used, and some lesser concerns for safe handling of compressed flammable gas and operation of vacuum equipment. A metal vacuum vessel will stop virtually all of the weak x-rays which may be produced (a little tamer than those produced by a television), and a thick glass window will stop most ultraviolet radiation produced. The voltages involved are somewhat lower than those present in an ordinary television set, which also has a large, fragile, glass vacuum vessel, and I would characterize the project as about as dangerous as television repair. They still teach television repair in high school technical education programs, don't they? But make no mistake, the insides of a television set can kill you in a heartbeat.

While you will wish to rig a method for detecting and quantifying neutron production (that being your proof you are making fusion), the levels produced by the machine described below should be so low you would have to stand a meter away from the machine for twelve days of continuous operation before you got a 100 mrem dose of neutrons (and that is a *trivial* dose). Most likely, the device will be run only for a few minutes at a time at actual fusion conditions. Still, if for no other reasons than the educational benefits and common sense, I would advise the experiment be done with due consideration to nuclear safety. For those wusses who don't wish to "go nuclear," or who cannot find qualified advisors, you can still demonstrate the visible glow by using a non-nuclear gas (the residual air in the vacuum chamber will do) running at below fusion voltages. In fact, even without producing fusion, you can do a lot of interesting and useful science with these devices.

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The expensive component is the vacuum system, which may have to be borrowed or scrounged. The pressure required can be achieved by a simple mechanical rotary-vane roughing pump (a two-stage "micron" pump used for refrigeration repair will do) if the system is compact and tight, although it would be preferable to have a higher-performance system. Such a pump, used, can cost around $750 (a lucky scrounger I know has stumbled onto several for $150 or less), so a borrowed pump will be a real advantage if you are as broke as I chronically was in high school. A vacuum chamber and some high-voltage and conventional electrical feedthroughs will be needed. A metal vacuum chamber with a thick glass viewport is far preferable, and I managed to find materials for one at a scrapyard for $30. I have built a small demonstrator device in a $90 plastic desiccator chamber, but it did not achieve good enough conditions for fusion, finally failed due to a stray electron beam heating the walls, and provided little protection against x-rays or ultraviolet light. Glass vacuum containers such as bell jars are fragile and consequently dangerous, and must be used with guards, face protection, and with great care. Spark plugs will do as high voltage feedthroughs, and spark plug wire for high voltage cable, for researchers who are "cash-challenged." Homemade vacuum instruments can be made from light bulbs or old vacuum tubes.[7]

I have achieved the blue glow of convergent ion focus using a furnace ignition transformer and a pair of high-voltage diodes. This will produce close to five thousand volts, and ignition transformers are usually current-limited to a level that *probably* won't stop a healthy teenage heart. Such a transformer will not produce significant fusion, but makes a pretty glow which will demonstrate the convergence effect.

Higher voltage and power can be obtained using a 15,000 volt (7,500 volt RMS centertapped) neon sign transformer with two high voltage diodes, which can produce over 10,000 peak volts DC, and considerably more current than the ignition transformers. I have successfully pushed such a transformer to 13,000 volts. This power source *can* produce measurable fusion. Before buying one, check with an electrical contractor who remodels commercial property, as they frequently dispose of such transformers from old neon signs. You would prefer the higher-current 60mA variety if you can get it, and need at least a 30mA unit. This transformer can kill, particularly if you use a capacitor on it to filter the AC ripple.

Deuterium gas is not radioactive, and can be purchased without special license through many gas suppliers, sometimes even through welding suppliers. A lecture bottle should cost around a hundred dollars, and you will also need a suitable regulator, which you may be able to borrow, or at least re-sell after you are done with it.

The reactor grids themselves will cost a few cents and take about an hour to build, if you have access to a small spotwelder. What, no spotwelder?!! Build one yourself with common parts from an electronics store[7]. Each grid can be formed from six rings of stainless steel welding wire. I have used 0.025 inch diameter wire, which is cheap and easy to work. Buy it from any welding supply dealer. Figure 2 shows how to fit the rings into geodesic spheres. The dimensions can be adjusted to fit your apparatus. Typically the outer grid is somewhere between the size of a beach ball down to the size of a volleyball, and the inner grid is from the size of a softball down to the size of a ping-pong ball. You may gather from this that precision in diameter is not an issue. It also is surprisingly unimportant that the grids be perfectly spherical or mathematically precise.

While a specially-built neutron counter is the most convenient way to detect neutrons, there are at least two

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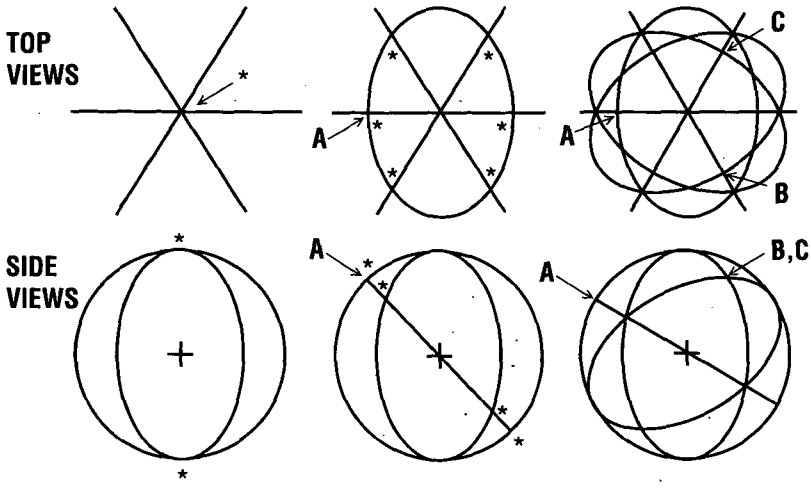
Fig. 2. Geodesic grid constructed from six wire rings



cheaper methods. Neutrons react with many elements to produce new elements, which are frequently radioactive. Plain old aluminum is one such element, and another is indium foil. Gamma rays from the products can be measured by a Geiger counter (I have seen plans for home-made models in reference 7), or can be detected by sensitive photographic film. Neutrons from fusion must be slowed down to make these reactions work, a process called "moderating." Two good moderating compounds are water and paraffin wax. There are also special plastics available which produce tiny flashes of light when hit by neutrons, which can be electronically or photographically detected.

A professional lab could probably manage to sink $50,000 in equipment for such a project. Purchasing used equipment, you could probably build a simple unit for well under $2,000. I suspect a particularly talented scrounge/beggar could get by for around $500 out of pocket, which I estimate could be raised in under a month of flipping burgers, or a couple of days of computer consulting.

At higher pressures (about one one-hundred-thousandth of atmospheric pressure), the system will work in "glow discharge mode," the way a neon sign works. This is the easy way to go, as it requires no fancy electron guns or extra power supplies. Those of you with access to higher performance vacuum systems may wish to venture to lower pressures, where the recirculation becomes far more efficient. This requires a source of electrons to generate ions. There are a number of ways to do this, but they are too involved for this article. These methods are described in the referenced papers, and can also be accomplished with cheap and available odds and ends.

If you jack the inner grid voltage on this simple little machine up to 10,000 volts or more, and feed deuterium to the system at a pressure a little under 10 microns, it should produce fusion, evidenced by neutrons. I have seen a 17-year-old build a grid

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that produced 300,000 neutrons a second at 13,000 volts.

So you see, you *can* build a fusion reactor with parts from an electronics store, auto parts store, welding shop, refrigeration supplier, hardware store, and craft store, perhaps with a bit of dumpster-diving on the side, and creative use of big, sad, pleading eyes. It really *doesn't* take tens of billions of dollars!

These hints should be enough to get you started. I don't want to describe the apparatus *too* completely, because hitting the books and figuring this out is how you earn that science fair prize dancing before your eyes right now.

Can The Problems Be Overcome?

While machines based on Farnsworth's Fusor are indeed easy to build, and worked better than any thermonuclear fusion machines until quite recently, it was immediately apparent to the researchers that they could never reach breakeven. The reason, quite simply, was that either configuration required grids, and grids simply could not be built more than about 98% transparent and be expected to support their own weight, especially as they typically run red hot when fusion conditions are achieved. The machines seemed doomed to operate at no more than 0.01% of breakeven. A few researchers struggle on, tantalized by the fact that the machines seem to have modes of operation which are better than theory predicted. Dr. George Miley of the University of Illinois has shown that a "star mode" develops in which recirculation passes primarily through the grid openings, reducing grid losses. There also appears to be considerable fusion occurring immediately outside the convergent focus region, where head-on collisions dominate, which was negected in early analysis. Still, these improvements fall far short of what is needed for a power reactor.

Basically, the grids had to disappear!

A way may be forthcoming. The actual inventor of the scheme below asked me to drop my original glowing testimonial. He is entirely too modest, if you ask me, but I understand his motives. Still, he isn't getting off without his name being mentioned here, and at least a few of his extensive accomplishments. You may have heard of him as the inventor of the interstellar ramjet concept featured in *Tau Zero* and many other science fiction stories: Dr. Robert W. Bussard. In the 1950's, he proposed and designed a workable nuclear fission rocket engine, which led to KIWI-A, the first predecessor of NERVA. KIWI-A was ready to test *before Sputnik was launched.*

Dr. Bussard also worked with Dr. Hirsch in the thermonuclear fusion program at the old Atomic Energy Commission, predecessor of the DOE. Both of them recognized the finer points of the IEC machines, and wondered if a way could be found to get around the grid problem.

When life hands you a lemon, it has been said, you should make lemonade. Dr. Bussard was struggling with another of his inventions, a small tokamak called the Riggatron, which looked marginally workable, but had turned out to be far too expensive to build with the available money. The enormous energy required to bring the magnets up to a field strength that would trap the plasma would require a monster flywheel-generator that was simply way over budget. The problem with tokamaks, he realized, was that ions are so damnably hard to trap with magnetic fields, particularly under fusion conditions. Yes, using superconductors, or by putting copper coils very close to the plasma and pushing them to their limits, it was possible to trap light ions like deuterium and tritium, but as soon as they collided they would tend to jump field lines, unless the fields were especially powerful. Achieving that field strength was turning out to be a killer problem.

It was a pity, Bussard thought, that ions are not as simple to trap with magnetic fields as are electrons. Because

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electrons are thousands of times lighter than fusion fuel ions, they are deflected easily by much weaker magnetic fields. If the little tokamak contained only electrons, they could be held at high energy and density quite efficiently. And then an epiphany struck.

It might just be possible to build an EXL machine with magnetically insulated grids.[8] The magnetized grids would accelerate electrons just as well as wire grids, but it would be next to impossible for the electrons to actually *hit* the grid. Ions formed just inside the grid would be drawn into the potential well and oscillate until they collided, totally unimpeded by grids, and trapped by the *one* thing that holds them vigorously—an electrostatic potential. From time to time, theory seemed to pose a fatal obstacle, but each time a closer analysis of the obstacle revealed a solution that made the theory work even better.

Funding was found to build a large-scale (1-meter radius) machine, which demonstrated that the system could produce a deep potential well. Further small-scale work showed successful magnetic trapping of dense electron clouds. Theory and computer simulation seem to support the models and experiments, with no roadblock problems found, yet.

The theory and preliminary lab studies look good. A few million dollars would fund a working prototype, and if that doesn't work, indications are that scaling up a factor of ten in volume almost certainly would. While not cheap for most of us, compared to the DOE budget for the last 20 years it is practically petty cash. Will it succeed? At this point, only time will tell.

The Possibilities

If successful, the impact of this type of reactor would be enormous. I need not describe the overall economic consequences in too great a detail to this audience: science fiction is chock-full of stories in which we developed cheap, clean fusion to replace petrochemical fuels and to power our spacecraft. However, Bussard's magnetic-grid EXL version of the Fusor shows promise as a power source that sounds like science fiction. One reason is that it doesn't have to run on nasty neutron-producing fuels like deuterium and tritium.

As mentioned earlier, there are many nuclei which can produce net fusion energy besides deuterium, tritium, and helium-3. Most of them are not commonly discussed, because they require far higher collision energies than DT reactions. Since DT reaction conditions themselves are a formidable challenge for *thermo*nuclear approaches, the other fuels are simply out of the question for tokamaks or ICF systems. These limitations become almost trivial in spherical convergent focus accelerators, however. By simply jacking the voltage up to a couple of hundred kilovolts, the electrons can be made to produce a deeper potential well, and the ions race to the focus region faster. This requires scaling up the hardware, but does not appear to require any great leaps of technology.

Among the fusion fuels is a favorite of Dr. Bussard: the reaction between ordinary hydrogen nuclei (protons) and boron-11. Boron can be mined as borax or other minerals, and is readily extracted from seawater. About 80% of natural boron is the boron-11 isotope. The fuel is plentiful.

The p-B^{11} reaction is ideal: When the two nuclei fuse, they form *excited* carbon-12, which is unstable and almost immediately begins to fly apart. In two rapid stages, it casts off an energetic alpha particle (a helium nucleus), then the remaining nucleus splits into a *pair* of alpha particles. The first particle, carries 43% of the reaction energy, and comes off at precisely 3.76 million electron volts, which turns out to be very handy. The other two alphas come off at an average of 2.46 million electron volts each, over a spread of energies. Finally, the reaction produces no neutrons or

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high-energy gamma rays. There is a little bremsstrahlung ("braking radiation"—basically x-rays) from collisions associated with the reaction, easily shielded. Alpha particles are dangerous if produced in your body, but can be stopped by the thinnest of shields, and are essentially harmless in a reactor vessel. Once they pick up two electrons, alpha particles become helium, a harmless inert gas. There is no radioactive waste produced in this reaction!

Lithium can also undergo similar reactions, producing charged particles, and is an alternative fuel for such a reactor.

Most nuclear power generation systems produce heat by one mechanism or another, which is in turn used to heat a "working fluid" to run turbines or otherwise do mechanical work. The process of converting heat to mechanical energy by such means is inherently inefficient. Rarely does more than about a third of the energy end up in usable electrical or mechanical form, and the theoretical limit is around 40% for most practical fluids, engine materials, and operating temperatures. This fact has depressed thermodynamics students for the last century or so, but there appears to be no getting around it using primitive "Promethean" technology.

While you *could* simply allow the alpha particles from the $p\text{-}B^{11}$ reaction to slam into the reactor walls producing heat, there turns out to be a much better way to extract their energy. Alpha particles, which are helium atoms stripped of their two electrons, have a charge of +2. Each of the particles produced by this reaction has a kinetic energy of around 3 million electron volts. An electron volt is the energy a particle of charge 1 will pick up when accelerated through a field of 1 volt. The reverse is true, too: To slow down a 3MeV particle with a charge of +2, simply decelerate it with a +1.5-million-volt electric field. The particle will just kiss into the charged surface, and draw two electrons from it, producing current at high voltage. This method has been used to extract small amounts of power from alpha-emitting radioactive substances, and should also work for a large reactor of the correct configuration. The correct configuration is a spherical vacuum chamber (which this reactor just happens to be) with several charged grids to pick off the lower energy alphas, and the outer walls charged to catch the high energy alpha. It should be possible to approach 95% conversion of fusion energy to electricity with such a system (the rest being lost to bremsstrahlung and a few other minor mechanisms). This is quite remarkable—a nuclear reaction which allows almost all of the energy produced to be *directly converted* to high-grade electrical power!

You might think that if nuclear energy is so cheap, efficiency would not be a problem. For power plants, particularly large ones, waste heat release can cause local environmental changes, either by heating a body of cooling water, or causing local weather changes when water-mist cooling towers are used. The cooling apparatus is generally massive, and can easily cost more than the actual power-generating equipment!

Waste heat in spacecraft is even more serious. Any nuclear-electric powerplant using gas turbines or similar equipment *must* get rid of the excess heat in order to operate. Since there is no air or water in space to conduct away the heat, it must be radiated. For a thermal-cycle reactor of sufficient power to operate even a modest manned spacecraft, the radiators will be on the order of the size of football fields. They end up being a huge portion of the dry mass of the spacecraft, and simply *ruin* the performance. Thus, a reactor that can produce electrical power directly, at 95% efficiency, has a *tremendous* performance advantage over its thermal/mechanical/electric counterpart.

(By the way, you have seen heat radiators on spacecraft in *Analog* artwork many times. Vincent Di Fate tells me

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that's what those "fins" are on the back of his sleek designs.)

Dr. Bussard has done some preliminary design studies on spacecraft that could realistically be built around p-B^{11} reactors. Most use a large and very powerful reactor of close to 10 billion watts capacity. While fairly bulky, with a diameter of around 5 meters, the reactor is mostly empty vacuum, with only the mag-grid and a few electron and ion guns in it. It is thus exceptionally light for the power produced. Supporting cryogenic and power conversion equipment should also be practical space hardware, and not especially massive.

Because the reactor produces no radioactive waste and only a trace of radiation, it will be safe to operate in the atmosphere. Using high-voltage electron beams to superheat gas, one could build either an air-breathing jet or a rocket (relying on on-board reaction mass). In space, the rocket configuration will be used. Because the reactor can work only if there are far more electrons in it than fuel ions, it is also "intrinsically safe": if you feed it too much fuel, it just chokes off.

There are many ways of exploiting the EXL reactor output to produce rocket thrust, but the fact that the p-B11 powerplant produces high-voltage electricity makes it particularly suited for arc-jet propulsion's meaner big brother. In a million-volt-plus electron beam the electrons are pushing lightspeed, so the term relativistic electron beam (REB) is used. With some heavy-duty R&D, it is expected that REB-heating can be made quite efficient, and should be able to impart high velocity to the reaction mass. Water would be a perfectly suitable reaction mass, as would almost any other handy and abundant material. REBs are not picky about what they blast to plasma. Dr. Bussard calls the REB-heated systems "QED" (Quiet Electric Discharge) engines.

For longer-range missions, where quick acceleration is less important, a more efficient rocket which uses the fusion exhaust directly could be built. This would be the system of choice for trips to the outer planets, or even out to the Oort cloud. Dr. Bussard calls these more efficient systems "DFP" (Direct Fusion Product) engines.

It would be possible to build a "single-stage-to-anywhere" (SSTA) rocket, useable in the atmosphere or in space, with this technology, but, for bulk transport, this would probably be less practical than having separate atmospheric shuttles (with wings), space transports (equipped for long voyages but stripped of wings and landing gear), and landers engineered for the various destinations. From a science fiction standpoint, though, the SSTA possibilities are really attractive.

What kind of performance could realistically be achieved? Try these figures from some of Dr. Bussard's papers[9,10,11]!

Low Earth Orbit (LEO) to Mars: 33 days, more or less, for high performance designs, or 6 weeks for economical freight-hauling variations. The craft are single-stage, with a 15-20% payload fraction.

LEO to Saturn's Moons: as low as two months, with a short coasting period. Again, the craft is single-stage, and has a 14% payload fraction

How would such a rocket affect the economics of space exploitation? Most estimates you have heard in the past were for multistaged chemically-propelled rockets, which can barely achieve Earth orbit, the upper stage of which must limp to the planets along painfully slow Hohmann ellipse orbits. Chemical rockets are almost all fuel and barely any payload. While rocket fuel is fairly cheap, rockets are not, and each flight has a high operating cost in labor and hardware. Dividing the cost of a large rocket by a payload mass somewhere just above zero gives a really depressing cost per kilogram. Efficient EXL fusion rockets, reusable for many flights, fast

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enough to make many flights before becoming obsolete, and with a high payload for each mission, can improve economics by several powers of ten. Consider the following colonization figures extracted from a more recent paper by Dr. Bussard[12], and I recommend you read these sitting down:

Cost to LEO: $27/kg (a price that compares favorably to the cost of riding the Concorde across the Atlantic).

4000 people on Earth's moon, each person with 25 metric tonnes of equipment, and each person receiving an annual visit back to Earth: $12 billion over 10 years.

1200 people on Mars, each with 50 tonnes of equipment, and an annual visit back to Earth: $16 billion over 10 years.

400 people on Titan, each with 60 tonnes of equipment, and an annual visit back to Earth. $16 billion over 10 years.

I leave you to ponder these figures, particularly in light of the projected costs of sending a few people to explore Mars with chemical rockets, typically estimated on the order of a hundred billion dollars per trip. In particular, consider what these numbers would mean to your personal chances of living and working in space. ■

Tom Ligon is a consultant and science fiction writer, presently working with R. W. Bussard at Energy-Matter Conversion Corporation. Tom would be glad to hear from any science fair projecteers seriously attempting the project in this article, either by e-mail (tomligon@compuserve.com), or by mail at 8825 Centreville Rd, #190, Manassas, VA 20110.

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Geoffrey A. Landis

OUTSIDER'S CHANCE

Life on the frontier is different—
and so are the rules for living there.

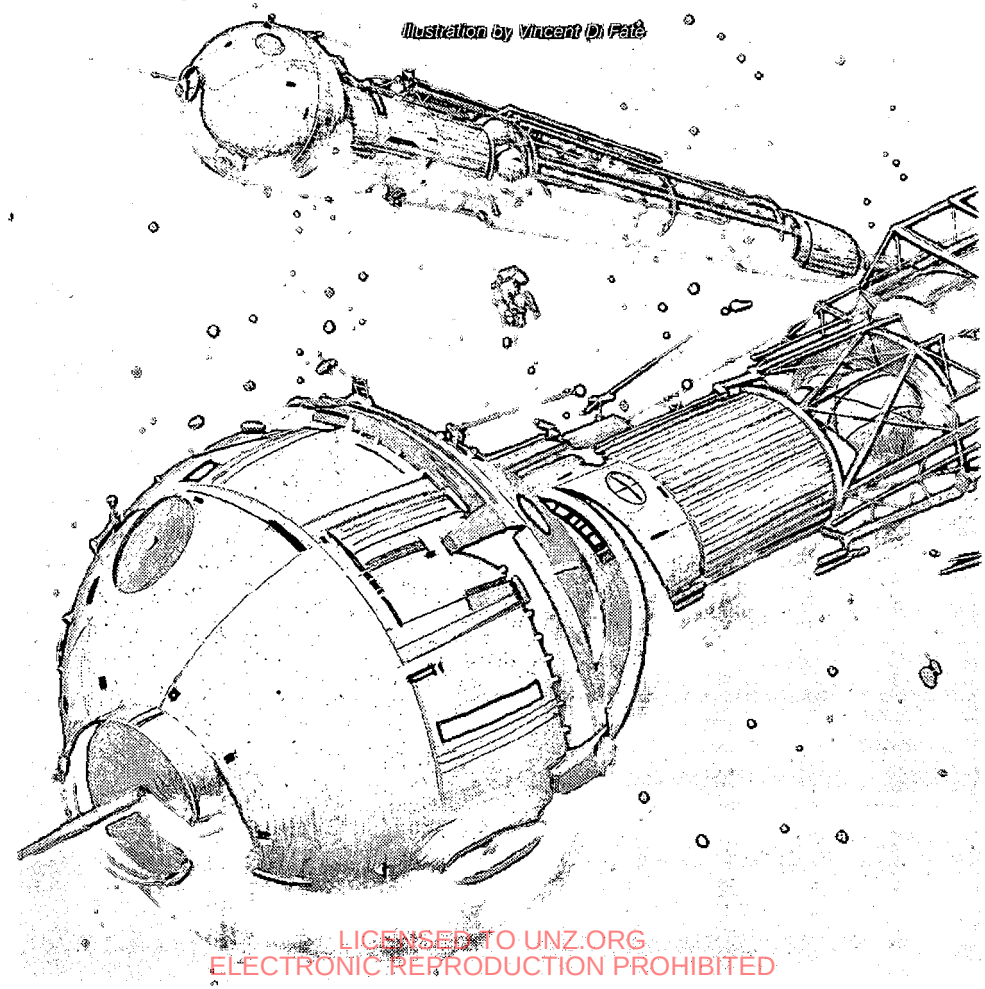

Illustration by Vincent Di Fate

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A nuclear thermal rocket is a touchy beast. It cares what you feed it. Hydrogen is best. Anything you feed into a nuclear rocket will give you thrust, but the lower the molecular weight of your reaction mass, the better your fuel efficiency is—the best impulse for the input, as it were. But you pay for that; the thrust goes down. Feed it something heavier, say nitrogen, and you don't get as good fuel efficiency. But you get more thrust.

I was feeding Bessie lithium this year. I would have preferred hydrogen, but I flat-out couldn't afford it. Hydrogen is expensive in the inner system; you have to haul it up from Earth, tank it in from the outer belt, or else dredge it out of the lunar soil molecule by molecule. Lithium is cheap, a by-product of fluorosilane production from regolith. And I had a little trick I could use, if I had to. Would've worked best with hydrogen, but it would still work with lithium.

Nuclear thermal is about the simplest type of rocket engine there is. The reactor core is an oven. You pump your reaction mass through the reactor core, it gets hot, and you exhaust it out a nozzle to get thrust. Working on a nuclear engine is what I do best, so I won't say it's trivial, but in essence it's no more than an exercise in plumbing.

Lithium's decent reaction mass, don't mistake me. It's great if you don't care much about performance: it's solid for transport, so it doesn't need to be pressurized for storage, but you heat it a little and you can inject it as easy as water. And it's nice and dense—well, compared to hydrogen. But to really get acceptable performance out of lithium, you have to run your core at about four thousand degrees, which is a damn sight hotter than hell. Bessie couldn't get those kinds of temperatures even when she was new, and she was long years from being new.

So I was at a double disadvantage; running cold, running heavy. Reactors get old. It's not like a chemical engine, that either works or it doesn't: when a reactor gets old, it still works, but you can't get it quite as hot—can't run quite as much reaction mass through it.

That's probably why I attracted attention. Anybody with a spectroscope could tell I was feeding lithium, could tell from the Doppler that my exhaust velocity was low and that my reactor core was old. It was obvious that I couldn't run fast.

I didn't have much of a choice. Bessie was mortgaged up to my eyeballs.

One of the previous owners had tagged the freighter Bessie, figuring it was a good name for a mule. Slow and ugly, but good enough for hauling ore. I'd bought her at auction after her last owner had been unable to haul enough cargo to pay the mortgage, and now the ship and the mortgage were both mine. I didn't bother renaming her.

Bessie had a crew of one, Ulysses Ahmed Tabibzadah: me.

The freight this run was oxygen. Oxygen's not a glamorous freight, not like the platinum-group metals from some wildcatter in the way-out, but it's a steady paycheck. I was hauling twenty thousand tons, three tanks of solidified oxygen, one tank of solidified nitrogen. And everybody uses oxygen.

Bessie's design was rather typical of a second-generation nuclear thermal rocket. The reactor and thrust chamber, with its oversized bell nozzle and maze of plumbing, sat at one end of a long truss of aluminum-lithium girders, with the spherical crew compartment at the other end. The truss served to put the nuclear reactor two hundred meters away from me, allowing the radiation shielding to be kept to a minimum. Behind the crew compartment was a utility room, which also served as the airlock. The tanks for the lithium were at the back, right ahead of the engine, close enough to the engine for heat-pipes to efficiently transfer waste heat to liquefy the fuel, and incidentally adding some additional radiation shielding. Bessie also had feedlines for cryogenic fuel, since the engine was designed originally for hydrogen,

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but at the moment nothing was flowing through these. And strapped to the outside of the main truss, like a cluster of mangoes strapped to an oversized pencil, was the payload, along with a sunshield of crinkled foil to keep it cool and a refrigerator to recondense the boil-off.

I was boosting a load from a processing plant at Hermes, pulling a steady twenty milligees. Time is money in the outer reaches as well as on Earth, but twenty milligees was as hot as I could push the engine. Still, a few weeks of twenty milligees would get me some respectable speed. As long as I didn't get hijacked.

The first intimation I had of trouble was the radar proximity alarm. At first I was surprised, then I was frightened. A proximity alarm shouldn't ever go off in the middle of a haul; space is empty. There are maybe a thousand ships spread across the outside hauling freight and ore between the asteroids and the Earth; considering the distances involved, after I'd boosted from the processing factory, it was incredible coincidence to find another ship within a million kilometers. And yet, the tone of the Doppler told me that a ship was here, and not merely flashing by on another orbit, but less than a kilometer away, and matching trajectory. It was closing with Bessie slowly, a few meters per second.

The radio was silent.

Hellfire and damnation!

How had it slipped in so close without a whole tabernacle choir of warning alarms? This was not good news.

Once I was aware of the other ship, it was easy enough to spot. With my good hand I cranked around one of the external cameras to zoom in for a look, while with my foot I punched my rendezvous beacon. There was no chance that they were unaware of me—there was nothing stealthy about Bessie, and the other ship's parallel trajectory couldn't be a coincidence. Nevertheless, prudent flight operations dictated that I squawk my position—mistakes in piloting were usually fatal.

With my beacon squawking, it was obvious to them that I knew they were there, and after a few seconds, the unknown ship's beacon also lit up. I read out the ship's details encoded on their beacon transmission. There was damn little to learn. Ship's name: *Love's Labors Lost*. Registration: <blank>. Ship type: <blank> Owner: <Not in data bank>.

A pirate.

I'd heard stories of piracy before; who hadn't? Ships that came to port minus their cargoes, other ships that never made it back. I'd never been sure how much credence to give the stories; it would be easy for a crew to divert their own cargo, split the profits, and claim piracy.

Now I knew.

The external camera showed me something interesting. Between the pirate ship and Bessie, struts held a sheet of metal mesh fixed to the pirate. It was nearly transparent in the visible, but I knew that in microwave frequencies, it must be operating as a phased array antenna. When the antenna detected pulses from Bessie's radar, it analyzed them, calculated the radar reflection, and synthesized a signal exactly 180 degrees out of phase. The result would be that Bessie's radar would detect nothing, up until the point where the pirate was too close to do anything about.

The pirate ship, or at least the side facing Bessie, was polished metal. The reactor in particular was shiny with layers of thermal blanket insulation. I had little doubt that the side I couldn't see would be black, radiating waste heat in all directions except mine. When I was a kid dreaming of space, I drew pictures of rockets with fiery tongues of flame licking out behind them. The reality is less spectacular. If a drive works right, the exhaust is *cold*. That should be obvious, right? The whole purpose of a rocket is to turn heat energy into kinetic energy. If the exhaust is hot, then there's still some heat you're not using. Tune it

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right, and the exhaust from a rocket should be cryogenic. So the ship wasn't radiating heat my direction. Result, stealthy in the infrared, too.

No communication from the pirate ship yet, although my squawk was broadcasting my receive frequency. The pirate ship was matching my 1/50 gee acceleration with ease, possibly waiting to see what I would do.

Not that I had very many options. In the big empty, twenty million kilometers from anywhere, there was nobody to call for help. And Bessie was, of course, unarmed. She was a freighter, not a warship.

I could run, but with a top acceleration of twenty milligees, they could easily match anything I could do. Loaded as she was, Bessie was about as agile as an ant towing an elephant—a lot of momentum once it got moving, but not much ability to turn quickly.

I studied the pirate ship with additional care. With a longer look, I could see that their ship was even older than mine. Like me, they were also running lithium, and the fuzzy Doppler I could get from their exhaust gave a lousy value for exhaust velocity. The reactor shielded behind that insulation must be at least twenty years old. The only reason they could match course with me was that I was loaded, and they were empty. I could drop my cargo and run. Unloaded, Bessie would run at over a gee of acceleration. This was probably what they were hoping I would do—it would save them the trouble of taking it away from me.

All this time the pirate was drifting closer. Now their stealth blanket retracted, rolling up and folding back against the ship, and their RCS thrusters slowed the rate of closure, preparing to rendezvous.

They were simply going to sever the struts holding the oxygen tanks, I realized, stealing my cargo without even bothering to talk to me.

There was little I could do about it. I could cut thrust, of course, but that would drop me behind their ship. Rocket exhaust may be cryogenic in temperature, but a supersonic stream of cryogenic exhaust will make tatters out about anything less than a thick steel plate. If I allowed Bessie to drop behind them, their exhaust plume would shred my crew compartment.

In fact, now that I thought about it, it was clear that they had no intent to harm me. If they had wanted to kill me and cripple the ship, they could have done it in a fly-by, probably killing me before I'd even known that they were there. Then they could pick what they wanted out of the wreckage. So they were thieves, but they had their honor. That made my job simpler.

They may have no interest in talking to to me, but that didn't mean I couldn't talk to them. I set my radio to the space-traffic control frequency, guessing that they would be monitoring even if there wasn't any traffic for millions of kilometers.

"Hello, *Love's Labor Lost*, this is *Bessie*."

An immediate response. "Yeah?" A male voice.

"What are your intentions?"

"We are detaching your cargo. Please hold your vector." I couldn't place the accent.

They were on station now, matching my trajectory perfectly, the two ships barely a meter apart. They would have to cut my fuel flow as well, of course—otherwise I would have the same advantage over them that they currently held over me. A blocked fuel flow would take somewhere between a hour and two days to fix, depending on whether they just crimped a feeder, or seriously crippled it. By the time I fixed it, they would be clear of danger. Even if I tried to chase, they would be ready for me, and there would be no way I could run them down and take the cargo back.

There was little point in protesting, but I did anyway. "Can't have it, it's not mine. Belongs to the company."

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"No shit?" The pirate didn't sound very interested. "Well, it's ours now."

I paused to think. I needed time.

"Come on over. Bring your crew. We can talk."

"Don't think we have anything to talk about. We're free. You're a company man."

"Come over anyway. I have coffee." That was a serious inducement. No hab in the solar system had enough agricultural margin to grow coffee beans. Real coffee had to be grown on Earth. Coffee, a hot bath, and bubble-gum: the three luxuries worth taking a trip downside for.

"Coffee, sure. And maybe a gun."

"No violence. With your ship shadowing me? You know I don't dare. And, anyway, I don't carry a gun. I'll bond, no violence. Outsider's honor."

"OK." A short pause. "I'll be coming over, then. Just me. The crew will stay here. I'm expendable, and my crew knows it." What he was saying was, if I tried to threaten him, the rest of his crew was ready and willing to shred my crew compartment, him and me together. If it wasn't a bluff, it meant that they were desperate. But I knew that already.

I watched him come out the lock. Only when he was halfway out did it occur to me to ask the same thing of him. "No guns on your part, either."

He unbuckled a belt around his suit and passed it back inside the airlock without protesting. So they weren't bluffing; he really was expendable. Also, this showed that he had at least one crewmate, and probably two: one in the lock, one flying the ship. Maybe more.

It wasn't too surprising that he would take me up on my offer to visit. Outsiders get lonely, spending months and years on trajectory. My one-man ship wasn't all that unusual, but still, it was most common to find a ship had a crew of two or three. On trajectory, you live without privacy, living in the pockets of the other members of your crew, every hour of every day. Other than members of your crew, you may not see a stranger for a year. When ships meet, crews visit. It was ancient custom when the surface-bound whalers of *Moby Dick* met, and, centuries later, it was still custom of the outsiders.

It was unusual for one crew to be a pirate, and unheard-of to meet on trajectory. But on the outside, politeness is as much a reflex as checking your airlock seal. I didn't expect any violence. Pirates or not, they were still outsiders, and outsiders know what it's like to live with a killer. We call it the big empty, and we know it intimately, a killer with no compassion, no compunction, and infinite patience, waiting for each of us. Downsides, they kill each other over honor, over sex, over a handful of smuggled cigarettes. In space, we don't kill each other. We know that death is waiting.

When I was a kid I lived for the day I would be able to go into space. I followed the excruciatingly slow process of building the first habitats, dreaming of how I would live in one; I drew pictures of rockets when I should have been doing English assignments, and floated weightless in my dreams. My father had been a penniless refugee, but he did well enough in his adopted country, and sent me to a school good enough that I could study the engineering that would be my ticket into space. Slowly, the development of space shifted, and instead of governments, the frontier changed to business. There were resources to be harvested upside, fortunes for a few who could develop them. Where fortunes waited, companies followed; and where companies went, banks were there to lend them money.

Getting into space is expensive, and once you're upside, staying alive is expensive. Most of the businesses failed. A few flourished.

There was plenty of work in orbit, if you could pay for the boost and the consumables needed to keep you alive when you got there, and the Kageshima-Sukhoi investment cartel was investing in loans to bring workers upside. I found work

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overhauling nuclear engines. After a few years, I managed to be paid enough to occasionally chip away at my debt.

If you've never been upside, there's no way to describe it. Imagine living in a three-dimensional maze of aluminum tunnels, a warren crammed and stinking with people, where air is something you pay for, privacy is a luxury, and a hot bath is a forgotten dream. Imagine floating in air softer than any feather mattress ever made. Imagine working in a cramped suit that smells of rotten sweat, your muscles aching from the fact that no suit ever gives you decent leverage and any error could kill you, and imagine fatigue so crushing that every move you make is in slow motion. Imagine looking upward and seeing the Earth hanging above your head, an ever-changing artwork painted by God in great swirls of white and streaks of green and brown and orange and yellow and all of it surrounded by an achingly thin membrane of atmosphere in the palest eggshell blue. Imagine looking down, and seeing the endless stars hanging below your feet, eternity sparkled with shards of diamond, and knowing that you are the tiniest and least significant part of creation, and yet you *are* part of it, and always will be.

I had a girlfriend. Theresa was in debt too, we all were. We moved from upside to outside: from low orbit into the outer reaches. We learned the outsider's code, and we began to find work. Work was harder to find, but the pay was intense.

And then we made a mistake: Theresa got pregnant.

Instantly she was ineligible for most work. It was a contract labor, and, upside or outside, the only benefits that any job in space offered was a free trip downside when you went broke. Nobody would hire a woman carrying a child—too much could go wrong. Theresa had to chose the child or her job, and she chose the child. I can't fault her. She forfeited on her debt, and Kageshima-Sukhoi gave her the one-way ticket down to that place we had once called home.

Perhaps it was for the best; she would have had to go downside to have the child anyway, since a fetus needs gravity for the last few months of development, and a child needs gravity to grow.

It was a girl. I never held her, but I've seen pictures. Theresa used to write, for the first few years; on lucky occasions she'd even call. But it's hard to maintain a relationship when we can be a thousand or a million kilometers apart, and time lag wasn't the only thing that made it feel like we were talking past each other. It's been five years since she's called.

Sometimes I wonder what's happened to her.

But I can't go down; I've been too long in microgee. Downside, I would be lucky to be able to stand up without breaking bones.

And, besides, I love it here.

Right up until the day that a company I was under contract to went bankrupt owing me eight months in back salary. Kageshima-Sukhoi was interested in money, not in excuses. Without a firm contract for work, I was headed downside, and with a record for defaulting loans, I would never get another ride upside—not in my lifetime.

Kageshima-Sukhoi was willing to deal. Nobody was making money overhauling nuclear thermal rockets in those days; new engines were entering service that didn't need as much maintenance, and there were plenty of nuclear plumbers scratching for business. I was barely staying in oxygen. But there were opportunities. Asteroid processing plants were gearing up to produce raw materials. Asteroidal ore was beginning to look like it might have a balance sheet competitive with lunar ore, but the companies doing the processing were bottlenecked on transport. To Kageshima-Sukhoi, that meant investment opportunities: they were pumping billions into asteroid processing and ore freighters.

So I bought myself an ore freighter. I figured I could do most of the maintenance on her myself, saving operating

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expenses. Kageshima-Sukhoi financed the loan to pay for her, and incidentally refinanced my own loan. It was a good deal for everybody.

Except that, three years later, there were hundreds of independent freighters spread across the outside, doing business between rocks, and half of them with newer and faster rockets than Bessie. The market was saturated, and nobody was making money. And my mortgage was due.

While I was waiting for the pirate to come through the airlock, I turned off the power to the oxygen coolers, commanded the solenoids that opened up the check valves, furled the sun-shields, and did a visual check to make sure there wasn't anything loose that would fall under acceleration. There wasn't much more I could do, except to start heating water. Upside, the cost of coffee is mostly the cost of transportation, and so the coffee that I had was a rich Ethiopian mix.

The airlock undogged, and the pirate came through.

His space suit was old. The seals had been replaced, the seams mended, and the overhaul job showed off painstaking care, but that couldn't disguise the pitting in the visor or the outdated fittings. It had no company markings; the places where the company logo should have been had been carefully scraped clean or painted over.

When he removed the visor, he had short dark hair and a beard cropped to about a millimeter, both showing traces of white. I could tell from his thin arms and wasted legs that he had spent years, probably decades in microgee. I could tell from the odor that they were short on clean water. I could tell from his eyes that he didn't entirely trust me.

The outsider's code: the person you meet might be your most deadly rival, but when you meet, you offer hospitality, and you help him if you can. Pirates lived outside even the outsider's code, but I wouldn't break it first. It's a tough universe. "Hello," I said. "Welcome to *Bessie*. Let me get you a cup of coffee."

Twenty milligees of acceleration was enough that on the average we drifted toward the surface that was designated "floor," but wasn't enough to serve coffee in an ordinary cup. I used my free-fall cups, which had a fine mesh over the open end that served to keep the liquid adhered into the cup by surface tension.

Pouring coffee in microgee is an art form. I pulled the pot in one direction, letting a thin sausage of coffee trail out, snapped it off with a flick of my wrist, and before the coffee-worm hanging in the air could contract into a ball, transferred the pot to my other hand and then used my good hand to scoop it up with the cup. Then I let that cup float for a few seconds while I repeated the performance with the other cup. Then I caught the falling cup and offered it to my guest.

"Thanks," he said.

I caught my own cup out of the air, and gave him a few moments to savor the coffee in silence. Eventually he spoke.

"You a plumber?" he said. It was more of a statement than a question.

Pouring coffee, I'd shifted the pot from one hand to the other to scoop the coffee. It had only been an instant, but he'd seen it, and every outsider recognizes the symptoms of radiation-induced neural apoptosis. You get it, if you're careless working on things that are hot, if you forget to pay attention to shielding, if you're young and think you're invulnerable. They call it plumber's syndrome, sometimes, because so many nuclear plumbers have it. It's not fatal, although the dead nerves would never heal, and my arm would be weak for the rest of my life. Think of it as the price you pay, learning not to be careless.

"No secret," I said, although in fact, I would prefer not to have him think about the fact that I was a nuclear plumber too much.

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"Why'd you quit?" he said.

I could have told him the whole long story, but I opted for the short version. "Money," I said.

He nodded. "Money," he agreed. "Not enough of it, for sure."

"You're from Anteros," I said.

"No secret," he said.

I knew he would be. There really wasn't any other possibility. Anteros was the breakaway colony. The rock that they had colonized was a good one, as Near-Earth Asteroids went. Close to the resources of the inner solar system, and yet a rock big enough to have resources: carbon, the light metals, veins of nickel-iron, solar-wind volatiles trapped in the regolith. It should have been ideal. And then they declared independence.

Nobody cared whether they called themselves independent or not. Their mistake had been when their new government decided to defer repayment on their start-up loans. The banks, the true masters of the outside, couldn't allow that; they had spent ten trillion European Credits to finance the colony, and they expected a return on their investment.

The breakaway colonists at Anteros had been ready for a fight, ready for a siege, ready for anything except what had happened.

They'd been ignored.

They'd failed at the first lesson of economics: nobody stands alone. Maybe they'd really believed that their little colony could produce all the necessities of survival after trade was cut off. Maybe they'd dreamed that others would stand with them. But there's too much manufactured downside. Earth likes the goods manufactured with space resources, but it can live without them. But a spaceship has two hundred thousand separate parts; a habitat ten million parts. We don't have the industrial base to make them all. Not yet.

They had had the best of intentions.

"I don't suppose," I said, "that I could talk you out of this."

"No," he said. "I'm sorry." He had the grace to look down. "I'm sorry," he said again. "But we need it more than you do."

There was nothing more for me to say. All the while, I was watching the pressure rise as the cargo tanks slowly heated. There was a lot of thermal mass; they didn't heat very quickly. I hooked my toes under loops on the floor, but for courtesy, I waited for him to finish his coffee. Then I cut the thrust.

He wasn't hooked in, but he had space reflexes, and removing a small bit of effective gravity didn't bother his equilibrium. Bessie started to drop behind the other ship, twenty centimeters per second squared. I had other things to worry about. A few seconds of this would take us into the danger zone, into the exhaust cone of the pirate ship. I yawed the ship, restarted the lithium flow to the engine, braced myself for gee, and hit the afterburners.

When the acceleration hit, he crumpled to the floor. He couldn't have impacted very hard, since I was accelerating at only half a gee, but I doubt if he'd experienced this much acceleration in years. Even if he'd been expecting it, I'm not sure if he could have stood up. It hurt me to watch him, but I had piloting to do.

In the viewports, the pirate ship was illuminated with a vivid, coruscating light. The exhaust of a nuclear rocket should be invisible; this wasn't. It must have been instantly clear to them that I had a new trick, but any realization on their part was a little too late. Bessie leaped forward, and began to run. I killed my yaw and initiated a pitch-up. This wasn't needed—it was obvious to both of us now that I could outrun them—but it was outsider courtesy, to keep their ship out of my exhaust.

I kept the thrust up for about half a minute. That put me at three hundred meters per second, relative velocity. If they chased, it would take them hours to catch up, and this time they wouldn't sneak up unwatched. I cut the thrust.

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"Shit," the pirate said. "You were a decoy. You sandbagged us."

I shook my head. "Sorry, no. Just an independent who couldn't afford to lose a cargo."

He was floating now. I think he'd twisted an ankle in the fall, but he didn't seem to have anything broken. Good; I'd hate to have abused hospitality that badly, even if pirates were outside of the outsider's code.

"But why?" he said. "Why did you pretend to be helpless?"

"Lord." I shook my head again. He was asking the wrong question, he should have been asking *how*. "What choice did I have? Hellfire and damnation, do you know what it's like to be an independent? Do you think I could *afford* to lose it? The cargo may be insured, but if I'd once been hijacked, nobody would ever be quite sure that it wasn't an inside job, or that I might not do it again. I'd never get another contract, not a good one. I'd be downside within a year. Shit, look at me. Do you think I could survive downside? Do you think I ever had a choice?"

His eyes looked hurt. "You could join us."

I shook my head.

"Really! I mean it." He was earnest now, almost pleading. "Why don't you join us? We could use you. To tell the honest truth, we could use your ship, and your oxygen . . . but we could use you as well. We're desperate."

"I know." I was tempted. It was a great dream, the dream all the outsiders had—to be free, to be independent, to throw off the mortgages and the debts that kept us tied to the banks and governments of Earth. Yes, I was tempted—but not seriously.

They were going to fail. In space, we're too dependent on Earth's resources, her industrial base. Too many things can fail, too many spare parts are needed, too many trace resources are too expensive to mine in space. The fact that they were reduced to hijacking oxygen—oxygen!—showed that they had reached the point of no return. They had declared independence too soon. There was no way they could survive. "I'm sorry."

I let him jump off the ship. *Love's Labors Lost* would pick him up; it would take them about an hour to rendezvous, and by then I would be long gone. I worried a little about that patched-together suit he used, but he assured me that it had thousands of hours of time on it, and he wouldn't trust anything else anyway.

My drive would have shredded him, if I'd used it, but I had no need for violence. Life is tough out here in the outside.

I'd explained it to him before he jumped. I didn't have to, but I'm sure that they would have figured it out.

I was running lithium in the drive. I was hauling oxygen. I'm a nuclear plumber, by training; a freighter pilot only because I couldn't get work. And, in the long months of coasting across the big empty, I had plenty of time to tinker with the plumbing.

Lithium and oxygen react.

What I had done was to rewire the plumbing of my cargo so that the boil-off from the liquid oxygen vented into the expansion nozzle of my engine. A chemical reaction is inefficient compared to Bessie's nuclear engine, but there was no way to beat a chemical reaction's thrust level. Effectively, I used the oxygen as an afterburner to the nuclear rocket.

That thirty seconds of thrust had used up a bit of my oxygen cargo, but I could tell my clients it was boil-off due to a cooler fault. Using the oxygen would shave my thin profit margin down a little, and make my earnings from the trip somewhere between infinitesimal and zero, but it was the only choice I had.

I had my chance; I could have declared my independence and joined them. They weren't wrong; they were just too early. And for the rest of my life, I will dream about the freedom I might have had. ■

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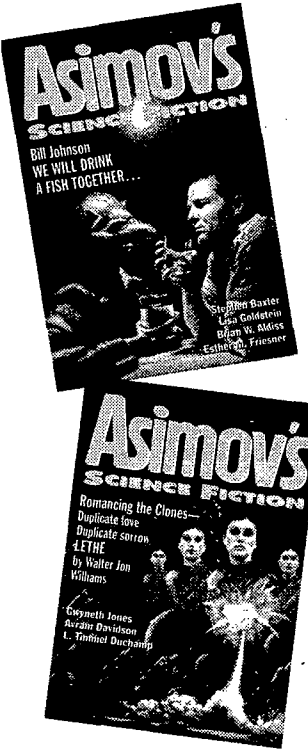

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Fran Van Cleave

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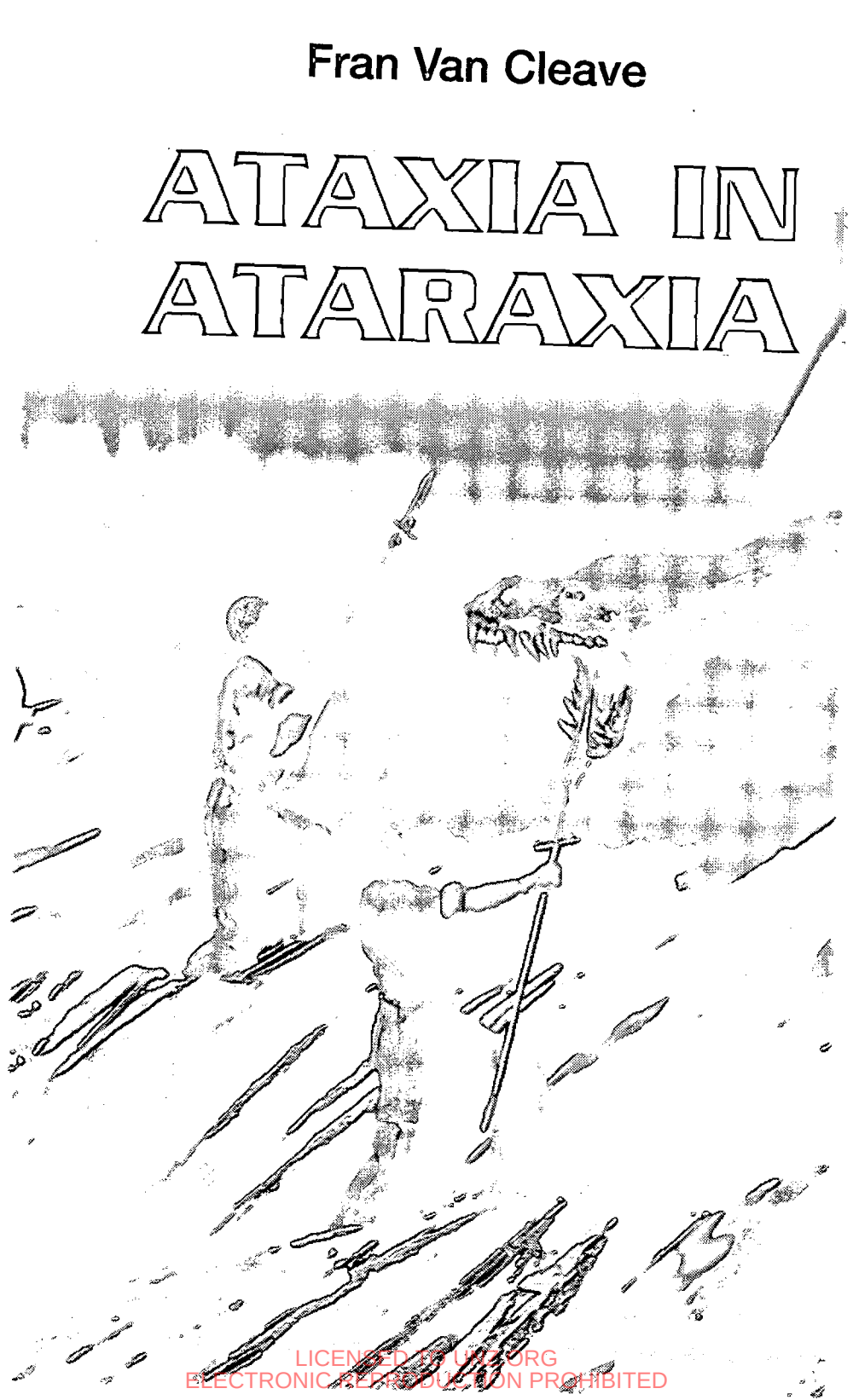

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Young people need role models, but any one culture permits only a limited selection. . . .

Illustration by Nicholas Jainschigg

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And with a mighty effort, Buck Rogers leapt out of the pit. And perished on the spears of the Saturn-dwellers, like the denormed savage he was.

Which is the moral of the play, you see—disharmony wrought by opposing nature will be punished by the Gods. It's bound to offend a few of the old *colonos*, possibly enough to start a spontaneous fad, but not enough to cause disequilibrium. The multiple-spear symbolism's a bit silly even for me, so we'll skip it.

Frankly, no one could be more surprised than I to be starring as Buck Rogers in *Look Homeward, Spaceman*. I lack the visual appeal for typical leads—I'm at that gawky stage of adolescence—but the casting director tells me I have this "deliciously primitive charisma." I can't see it. I think he picked me because of my resemblance to Dad.

Dad's the most famous former spaceman on Tierra Florida. Before he founded our city, he flew a ship between here and Elfour, our sister planet. In fact, he was part of the original colony who came to Elfour from Earth on the *Gates*.

I don't care if it's forty-seven light-years or four hundred and seventy—and frankly, I can't remember which it is; Quil Dust does that to my memory—a trip from Earth hardly counts as space-travel when all you do is hold meetings in your cabin. Dad was a lawyer for the United Earth Merchandising Co., whose ship they were on, but he didn't even see them make the MacIntosh transition point. He was asleep, probably worn out from all those meetings.

Fate catapulted Dad to fame via a microbe. About three years after planetfall (TF-years or Elfour years; it'd be one and a half Terran years for anyone who cared) the Yang bug hit.

All three of the microbiologists died in the epidemic, which left the survivors with few means for determining the bacteria's origin. Theory said it couldn't be alien, since opportunistic organisms are supposed to evolve in concert with their hosts. Maybe the bug didn't care as long as it could get iron-based blood protein, or maybe it came from the *Mustafa Kemal*, a non-UEMCo ship which had recently stopped to trade.

Whatever the case, Elfour's only pharmacologist, Dr. Seymour Patel, found a cure right here in the rainforests of Tierra Florida, which in contrast to Elfour is bursting with valuable plant life. Unfortunately, the good doctor had the bad sense to try collecting intact pods from the Harmony flower instead of being content with harvested gum, and was eaten by a *boca* for his trouble. Dad saved the colony by flying back at high acceleration with Patel's notebook and approximately twelve liters of gum extract, which contained two powerful antibiotics as yet unknown to medical science.

Of the fifteen hundred colonists, some four hundred had died and a hundred or so recovered; the extract saved possibly two hundred lives.

Dad said the colony wasn't as grateful as it should've been—that was inevitable, given the deplorable nature of humankind in general, and colonials in particular. I suspect that his timing had something to do with it, but his fellow colonists must've become reconciled to it, since more than three-fourths of them decided to follow him here on the next ship that came through.

Colonel J.S. Daggs, the colony's leader, and two hundred ninety-seven others never reconciled with Dad. They chose to remain on Elfour despite the Yang bug, severe winters, and all the other discomforts of that high-gravity planet.

It must've been a bitter divorce, dividing up the goods meant for one colony into two. The Elfourans kept all the domestic animals except for a few chickens (and thank Tranq for that—I've seen stereos of "mules" and they look absolutely terrifying). Dad says that all of the women chose to follow him to Tierra Florida rather than stay with Daggs's

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denormed diehards, but I find that a bit implausible.

Since virtually all the colonists were married, that would mean that almost a hundred and fifty marriages dissolved (unless we assume a radically unequal death rate). It just didn't make sense to me, and in fact, Summer Tsui's mom told me once that somewhere around a hundred women stayed behind.

Which would make the ratio three men to one woman—not impossible, I guess, but who'd want to live like that? I have a hard enough time attracting female attention as it is.

I've often wondered whether it was the unequal division of machinery or the women that most infuriated the Elfourans. They don't communicate with us, so I've no one to ask.

All this happened before I was hosted, so it's acquired something of a mythological flavor. All the old settlers—the *colonos*— act like they're the greatest thing since Flor sauce on tofu because they discovered this place, and frankly us kids are sick and tired of hearing about it.

Opening night, *Look Homeward, Spaceman* was a big hit with the ArtFad crowd. Afterward, Faerie presented me with a prize for the best death scene. She wore a little Roman g-string with silver chain mail and a short sword on her hip—very Classic Olde-Earthe. Between her perfect breasts dangled a pair of gold dog tags bearing her vrillname: *Julia Caesar*. I'd join her legion in a nanosecond.

I asked her what she was doing afterwards, and she batted her purple eyelashes at me. "Poffing Marc Antony and Cleopatra."

So much for my "deliciously primitive charisma."

She didn't invite me along, which was fine, because I want her to poff me, not Marc Antony. Besides, Cleo's too Amazon for my taste. I know it's atavistic and anti-harmony, but I fantasize about having a *chica* to myself, and I don't want to get into bed with any boys, *or* girls with less than ten percent bodyfat. I tried it twice, at SexForum with the other kids, but both times it was a complete failure.

My HealthMon says I'm neurotic even for a fifteen-year-old—it's programmed to use Terran years instead of normal ones, or I'd be neurotic at twenty-seven instead—but it won't force me into sex therapy yet. I could still grow out of it.

When I got home, Dad was still up, talking to someone on the radio in his study. ". . . very good, Commander. I'll see you first thing in the morning, then . . . why, certainly . . . think nothing of it."

The only commander I could think of that Dad was so friendly with was Commander Ralston of the *Spice Trader*. That was our annual UEMCo tradeship, which usually arrived right at harvest or maybe a day after.

For a minute I thought I'd lost track of a ten-day, and then I realized that even if I had, nobody else would've. Tradeship arrival always means a fiesta.

Dad signed off, and I said eagerly, "What's *Spice Trader* doing here so early?"

"Ralston wants to give his men a ten-day shore leave. I gave him my permission."

"Oh." That left our correctees plenty of time to get the harvest in. Not that I cared; my main concern was to get first pick of the trade goods.

Dad glanced at my prize, pursed his lips in that disapproving way he has, and said, "What in the Eye of Tranq is that?"

I hefted the misshapen blob and said proudly, "It's a cup you can't drink out of, sir. I won it for my Buck Rogers death scene."

He frowned. "I don't recall instituting a fad for useless objects."

"It's a spontaneous," I told him, wondering with ten percent of my brain why he wasn't keeping track. The rest of me was *tranquilo* on Dust, imagining Faerie madly in lust with me once I got one of the elaborate new full-body tat-

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toos—should it be the Battle of New Orleans, or the Alamo?

"Why is a cup you can't drink from considered a prize?"

"Huh? Oh . . . I guess you'd call it the principle of uselessness. The kids are all making art collections out of useless things. Uselessness is vrill." Cutting-edge definitions were tricky with a headful of Dust, but I fancy I did an excellent job.

Dad simply stared at me, with those greenish-brown eyes exactly like my own. (I'm thinking of having a few eye-wrinkles added. My best friend Booter—he hates it when I don't use his vrill-name, "Napoleon"—swears by it for charisma.) "This is the thanks I get for creating the perfect society. My son wins a useless prize for ridiculing me and my founding of this city."

My hand clenched on the blob until my knuckles whitened, and I looked down at my toes. "That's not it, Dad."

But he was off and running. "You don't have a clue what I've sacrificed to build Ataraxia. That's so typical of the young. You take everything for granted, but then I suppose you can't help but be a product of your environment." The disdain in his voice made me squirm.

When I looked up he was staring glumly at his wallscreen, which was covered with columns of figures. "Do you know what these figures mean?"

I could've hazarded a guess, but I said, "No, sir."

"Our profits and expenses for the last five years. You can see from this line," He pointed one of his long pale fingers, and the descending line glowed crimson, "how profits from the plantation aren't keeping up with our spending. Another quarter like this, and UEMCo's going to shut off our credit. Unless we go through with the iron-plankton project."

I made an effort to focus. "What's so terrible about the iron-plankton project? I'd like to go outside without a breather mask. Of course Tranq doesn't want us to alter nature, but . . . "

Dad's face reddened with anger, but for once, he didn't shout at me. "Don't talk nonsense. The minute we stimulate enough plankton to drop the atmospheric levels of CO_2 by one-third, UEMCo will start dumping Terran transportees on us by the freighterload. Almost as bad will be the subsequent decrease in production of the rainforest plantation. If you occupied your brain with something besides uselessness, you'd know these things. Frankly, I have doubts you'll ever make Administrator, even if I am somehow able to afford to ship you Earthside for college."

I didn't want to follow in his footsteps, but I couldn't tell him that. "I'd make a *great* Administrator," I said with a witless grin. "I'm already a lieutenant colonel in the Fairweather Army Wargames. In fact, just yesterday Booter let me lead the saber charge against the Amerinds." I slumped against the door, equilibrium waves pulsing through me, calming my agitation. "Or was it the Caucasians? I always get those two mixed up."

Dad made a disgusted noise. "Rafael, enter the real world. You're going to the Devil's Snowchalice with me."

"Skiing? Gee, Dad, that'd be fun, but . . . "

"Shut up. What's more relevant to our concerns in those mountains than skiing?"

"Uh . . . the runaways at Hole-In-The-Wall town."

"Very good. You'll make Administrator if it's the last thing you ever do." Dad shut off the screen and stood up, stretching his back until it cracked noisily. "I expect those worthless correctees to run away from the plantation, but when they try to bring Ataraxia crashing down, they force me into action."

Sometimes reverse psychology works, and sometimes it doesn't. I braced myself for another of Dad's paranoid fantasies. "What've they done now?"

"They built a rocket base in the mountains, and started trading with Elfour. They're being exploited, the stupid

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fools, but they don't know any better. That bastard Daggs is behind this."

A tributary of excitement snaked its way through my nervous system. Colonel Jackson Sequoia Daggs, here? As a kid, I'd fantasized rescuing him after his ship crashed in the rainforest, bringing him a breather mask, or whatever. The memory of such boyhood idiocy made me blush. "He's still alive?"

Dad shrugged. "His ship's here—*Spice Trader*'s imaging systems located it a few hours ago."

I almost wished I had the time to check into it. Seeing a barbarian or two up close might be fun. Unfortunately, my free time was limited, so I had to be practical. Assuming the colonel was still viable, I couldn't imagine any interaction between him and Dad other than your typical tail-thumping saurian battle for dominance. In which I'd play zero part, so forget it.

"That's awful, Dad, but why risk yourself when you can send the Guardia to teach those savages a lesson in interplanetary diplomacy? I'd love to see it, but I'm afraid my HealthMon won't allow me to experience anything so radical right at the moment. I'm too depressed."

What I really needed was to take my pick of new clothes from *Spice Trader's* cargo, so I'd look vrill when I bumped into Faerie at the fiesta. If I didn't press my advantage, she might forget all about me. And then I really *would* be depressed.

"I don't care what that silly machine says, Rafael!" He banged his fist on the desk, making the silicon statue of Tranq wobble dangerously. "This trade *will* stop. And you're coming, whether you like it or not!"

"Tirali won't allow it," I said, but it cost me the rest of my equilibrium to sound so confident.

I knew right then my bed would have to give me a Number Three Soothing Erotic Massage and then spray me with Morpheus Mist and Honeysuckle Soother to get me to sleep.

Dad's an utter throwback. If I weren't his clone, I swear he'd put me in total disequilibrium.

Next quarter-day afternoon, I found myself sitting in the passenger compartment of Dad's flier, H.A.S. *Implacable*, clad in thick-soled snow boots, and I kid you not, waterproof polyester pants (couldn't he come up with something a tad more *macho*?) watching Ataraxia shrink below me like a child's toy.

Thank Tranq the other kids didn't see me wearing these old Elfour clothes of Dad's! I didn't mind covering up my skinny legs and big feet, but such unvrillness would ruin my budding popularity. He'd promised to get me back in time for the play tonight, so I'd be able to attend the fiesta afterward. . . .

I'd made it to the shuttle early enough to find a beautiful spider-weave combat shirt that fit me perfectly, and a platinum earring that the trader swore belonged to a real Space Marine who went AWOL in Sigma Draconis and needed the credits to get home. A lie, no doubt, but none of the other kids will know, so what difference does it make?

At this height, two klicks above the city, all the buildings looked like small bricks—not surprising, since that's what they're made from. The big red-orange sun stood a hand's-breadth below the midheaven, its outline sharp and clear now that the morning fog had burned off. Sunlight picked out the upper curves of the plastic habitation domes, which made me think of an egg clutch in a quetzalcoatl nest. I didn't see the shuttle on the landing pad, but figured it must've gone back to the ship.

Several bright-green and yellow flyers launched themselves off the cliff for a glide over the ocean. I scanned the entire area for a quetzalcoatl, but thank Tranq, didn't see any.

I hadn't really expected to. The hideous creatures spent ninety percent of their time gliding thermals, sleeping, or poffing their equally repulsive coun-

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terparts (the difference between male and female q's matters only to another q). Now that the flyers were painted to resemble their enemy, the Chartreuse hawk, they usually stayed away.

Smogbog is Tierra Florida's first name, given by the original explorers, who disliked the thick morning fogs and high partial pressure of CO_2. High compared to Earth and Elfour, that is. Despite this minor breathability problem, I figure any sensible person would rather live in a bubble-city by the sea, adjacent to a sweet-smelling and productive rainforest, than in a dirty, drafty log cabin on Elfour.

Dad's voice boomed over the intercom. "There's the most gorgeous view in this part of the galaxy."

"It sure is, sir." As if I had a clue what else is out there.

"As Administrator, your most important duty will be to keep it that way. Maintain paradise at a growth rate of five percent or less."

"Yes, sir." I've heard it umpty-ump times: I designed paradise to last forever, so you mustn't be expansionist or you'll ruin it. Ataraxia comes from OldGreek, translated as "neither too high nor too low, the perfect intermediate state of being."

Since I haven't seen the rest of the solar system, let alone the galaxy, I have no basis for comparison, but Dad never tires of hearing how great his works are. When I was little, it put me in disequilibrium wondering how I'd ever live up to them—but I realize now it doesn't matter. How can I compete with my own twin? When I'm grown, people will mistake us for the same person. As vain as he is, there's no way he'll *not* keep regenning.

One day, will I stop correcting them?

I could see the limestone cliffs where Alaric and I used to climb, not far from the plantation; I could even see Disequilibrium Cave. We'd made it all the way up there once—in spite of the older kids' stories about ghosts and alien monsters.

Well, if they hadn't had ghosts then, they certainly had one now.

Implacable pivoted above the cliffs, and we hit a patch of rough air. I swallowed hard and stared out the window.

This morning, when I'd risen so early to meet the shuttle, I'd looked for *Sangrón*, the Daystar.

It wasn't really a star, of course, but a gas-giant planet whose gravity well kept us and Elfour perpetually together—in astrophysical terms, that is. The sister planets remained a permanent hop, skip, and a hundred fifty-eight million kilometers apart.

I'd found the tiny red disk in the western sky just as it dropped behind the extinct volcanoes of Isla Vista. A bad omen. Not that I truly believed in such things, but . . .

Sighing, I stared at the red-gold rainforest canopy rushing below like water in a mossy creek, white Harmony flowers floating here and there like *nenúfar* pads.

If I threw myself out the airlock, would Dad care? He says my four halfbrothers and sisters would never make Administrator in a million years, but I know he didn't leave Earth without backups. I've seen the other two embryos in the freezer. The first clone, Felipe, died of a scorpionbug sting at age seven. I know dad loved him best.

But why do I dwell on such denormed thoughts? Suicide's a permanent solution to a temporary problem, with the added defect of making it impossible to know whether Faerie had changed her mind about me yet.

"You could at least *try* to sound a little more enthusiastic, son."

"I have a headache." The turbulence made me regret my big breakfast, and the sterile air inside the flyer didn't help. Scowling, I punched my symptoms into my HealthMon. Too much to expect fresh flowers in here, I suppose, or even the most minimal perfume palette.

After a moment, the diagnosis appeared on the screen:

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YOU ARE SUFFERING FROM AIRSICKNESS.

No kidding, I thought crossly. The last thing I wanted to do was take an anti-nauseant nebulizer from the first-aid kit, and have Dad look at me like I was some kind of bootcelled version of him. He was *never* airsick.

I sniffed a little Quil together with a squirt of my own Cinnamon Mist, then sat there with my head in my hands, feeling sorry for myself. If Tirali had been my *real* mother, she wouldn't have allowed this. But I guess I can't blame her for wanting me gone. We've been mutually uncomfortable since I hit puberty.

She's ninety-nine (and holding, as they say), but regenned to look fortyish and gorgeous. I can't imagine her as a pioneer or a botanist—it takes her hours just to redo her sarongs to complement a new tattoo. She and Dad had a fight this morning about her new escort.

Maybe Dad's having a century-plus crisis. Lots of men have it when they pass the century mark, and he's a hundred and thirty-eight. No wonder he's resurrected his Terran roots, inflicting this bizarre coming-of-age ritual on me. It would also explain why he's jealous of an escort. She's his fifth wife, why shouldn't she have an escort?

I sure prefer it to having her flirt with me one day and take it out on me the next.

About ten minutes later, Dad opened the door to the passenger compartment, and said, "How're you doing?"

"Fine," I said flatly.

"Would you like to switch the aircraft to manual? I can give you a flying lesson."

"No, thank you, sir." I ached to learn how to fly, but he'd strong-armed me here, and I refused to act like that was OK now.

Dad smiled sadistically. "Think of all the inspiration you could get from agonizing about the landing. You could make a sculpture of an aircraft with no landing gear. How vrill!"

I glared at him. "Very funny."

In the misty distance I saw the four peaks of the Devil's Snowchalice, rising out of the rainforest like an iced dessert sculpture in a gold cup. What sort of denormed runaways would build a town and a spaceport in so inhospitable a place? Frankly, I'd begun to wonder if perhaps they were too tough for the Guardia. And Colonel Daggs, if he even remotely resembled his old fire-breathing barbarian image, would never go along with it.

I sniffed more Dust, this time with Passionberry Musk, and took a brief nap. I dreamt of falling, and it went on forever, though I couldn't have been asleep more than five minutes. Oddly, I felt no erotic component. I'm sure I didn't attain the five stages of sleep in their proper order.

As soon as we return home, I should have my hormonal balance checked. My HealthMon says the oscillating hormone levels of adolescence make it virtually impossible for young males to stay normed.

We landed; I unstrapped and put on Dad's heavy shirt lined with blue Exoplex, then the jacket. It's light tan, which at least looks good with my skin. It took me a moment to figure out which arm went where.

A half-dozen of the Guardia exited the aircraft first, then Dad, escorted by his bodyguard, Harry McCann, and then me.

I squinted in the bright sunlight, and shoved my hands in my pockets. It was *cold*. Dad said Elfour had terrible winters because of its axial tilt. Since the temperature never varied here at sea level by more than ten degrees C, I'd never really thought much about it.

Could it possibly be colder than this? Why in the universe would anyone put up with this for twenty entire days each year?

It didn't bother me to stand outside without a breather mask, since I knew the air was human-compatible at this altitude, but the cold made my nose tingle, and froze my nasal passages with

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each breath. I put my hand over my nose and mouth. Much better.

Across the bare, icy ground, I saw several of the barbarians swarming around what must be Daggs' ship, *Lady Liberty*. Its blocky body, ridiculously stubby wings and dented gray finish made me wonder how it'd ever got here all the way from Elfour. On the other side of the field, I saw two personal flyers, like the ones the cliff-divers used, but dingy and beat-up looking.

Obscurely disappointed, I turned away, studying the piles of loose stone and broken tree limbs piled in back of the landing pad. The trees here were ugly, stunted things with prickly leaves, barely worthy of the name. In the background, I heard the noisy throb of machinery, and men shouting. Hole-In-The-Wall, where the runaways lived, could not be more than a kilometer away.

"We should've brought more Guardia," McCann muttered.

Dad waved it off. "Twelve's plenty. If we look too threatening, I won't be able to get the Elfourans to agree to anything. You remember how pigheaded they are."

McCann grimaced. "And how dangerous."

"Ssst. You sound like an old woman."

The bodyguard gave him a crotchety look. I thought they were both too old for this, but nobody wanted my opinion.

Two left the Elfour ship and headed toward us. Tall and heavyset, they wore tawny yellow coats that looked like something made from oroweed-fluff, and moved with long, bouncy strides—a funny-looking gait, but the gravity on Tierra Florida was less than three-fourths what they were used to. Their brown trousers were tucked into soft grayish-brown boots, which came halfway up the calf.

"Howdy," said the taller one, touching the brim of a green slouch hat perched atop his shaggy red hair. He had gray eyes and the thickest beard and moustache I ever saw—not surprising, I guess, since most Ataraxian males use a beard depilatory. "You fellas lookin' for somebody?"

Dad stiffened in annoyance. He expected to be recognized on sight. "I'm Administrator Mondragón. This is my son, Rafael Felipe Aguilar de Mondragón II, and my bodyguard, Harrison McCann. I wish to meet with whoever's in charge here."

"Pleased t'meet ya, Mr. Administrator!" The redhead stuck out his hand. "I'm Grimcat Smith, and this here's my partner, Thaddeus O'Rourke."

The hand-motion was so quick it startled me, and I stepped back involuntarily. "Grimcat?" I said, wondering if I'd interpreted the villainous accent correctly. "What sort of name is that?"

"Short for Grimaldi cat. Indigenous to Elfour." Smith grinned, and I found myself focusing on his canine teeth. They weren't any larger than normal—or were they? (Everyone knows these barbarians are meat-eaters.)

I'd seen a picture of a cat once, and it hadn't looked very friendly—more haughty. This one seemed friendly enough, but I didn't doubt that anyone who could move that fast must be dangerous. McCann had better keep an eye on him.

"Glad you could drop by." O'Rourke held out his hand, which was big and square and, except for the palm, as brown as Smith's was white.

Dad flashed his perfect smile—he can be charming when he wants to be—and we all went through the motions of shaking hands. I wondered if the two barbarians were ill. They looked on the young side of middle age, sixty or seventy, maybe, but their hands were nearly as hard as stone. I'd never heard of a disease that hardened the extremities like that.

"Well," said Dad pleasantly, "shall we get out of the cold and wait for . . . whomever?"

"It's Dr. Mbinga," O'Rourke said. A cloud seemed to shadow his square

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brown face. I wondered if he'd been in the original colony. But no, he couldn't have been, or Dad wouldn't have needed an introduction. Dad was a consummate politician; he never forgot a face.

The redhead scratched his beard. "She's busy in the lab. We're liftin' off in a couple of hours."

"She'll want to know I'm here," Dad said. The assumption of unquestioned obedience radiated from him like heat from the sun. Which would've been welcome now, since my toes were freezing.

It was undignified, but I couldn't help stamping my feet. Melting ice crunched under my boots like sheets of wet mica.

"Guess I oughta tell her you're here, huh?" Grimcat smiled. He glanced at the *Implacable*, and the six Guardia standing at attention around it. "Well, let's go inside 'fore we freeze our wallies off." He turned and strode through the snow toward the ugliest building I have ever laid eyes on, a squat brown structure of unfinished lumber.

"After you, Administrator," said O'Rourke, extending his arm.

I don't think Dad even glanced at the ship.

Besides O'Rourke, Smith, and Dr. Leslie Mbinga, one other sat at the meeting-table with us: a slight, nervous-looking fellow with the unlikely name of Sundance Kawasaki-Jones. All four were clad in rough brown pants like my own, and crudely woven shirts rolled up to the elbow in butternut yellow, copper-salt green, or gray. They'd come in wearing knives on their belts, blasters on their hips, and pointy-toed boots—even the doctor.

They'd refused to take their blasters off until McCann took his off and the Guardia went outside, and Smith didn't take his filthy hat off until Dr. Mbinga came in. None of them used any personal scent whatsoever, or if they did, it was drowned out by the smell of sweat lingering on their clothes, mixed with woodsmoke and the cheap panfruit alcohol used for jeep fuel. Dad smiled the whole time, but I knew what he was thinking. Really, what *can* one think of such people?

Dr. Mbinga was almost blue-black in color, skinny as a twig-doll, and looked old enough to've witnessed Elfour's collision with a planetoid fifty million years ago. Her hair was snow-white, the whites of her eyes were red, and though the skin fit tightly over her high cheekbones, she had enough wrinkles elsewhere to make up for that with interest. And except for two gold hoop earrings which dangled from her pendulous earlobes like gaudy instruments of torture, she wore no makeup or ornaments (unless you count a clunky watch) not even the simplest tattoo. Her tired brown eyes regarded Dad with amused suspicion.

"Well, Rooster," she said in a voice that crackled like the dried skin of a *plateado logardo*, "the years have been good ones, I see. You always had a talent for landing on your feet. What can I do for you?"

"You can start by calling me Administrator Mondragón," Dad said stiffly.

"Hmpf! I liked you better when you were young and arrogant instead of old and stuffy. Instead of, 'what can I do for you?' I'm going to switch to, 'What the Hell do you want this time?'"

"You've no right to speak to me like that. Must I point out that if it weren't for me, most of your patients would've died in the epidemic?"

"And we appreciate that, Mr. Administrator," Grimcat said easily. The pale electric light made his hair look like copper wire—almost as red as the carnelian stone I found on the cliffs with Alaric. "Back home, we're a mite more informal than I expect you're used to. If you're offended by that, I'm sure she'll apologize."

I thought maybe he was being ironic, but then I decided he wasn't. I mean, he just didn't seem that smart.

Their coats off, he and Thaddeus were living tribute to Elfour's higher

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gravity. Both of my legs might've made one of Grimcat's arms, and I thought it both wonderful and repulsive.

Dr. Mbinga grinned, her teeth astonishingly white in her dark face. "I do not forget the ones you helped me save—nor how you used that lever to break our colony in two. It would've happened sooner or later, so I hold no grudge. But I've neither talent nor time for flowery protocol. We are on a tight schedule, and I have to get back to the lab soon."

"What you don't seem to realize," Dad resumed frostily, "is how this operation of yours affects me. Spaceports are notoriously disruptive. I've no doubt that within a year or two, this place'll be luring young people out of Ataraxia in search of excitement. I went to a lot of effort to found my city in a peaceful natural wonderland where we could live in absolute harmony, uncontaminated by other cultures. You're ruining it."

The doctor raised an eyebrow. "*We're* ruining things for *you*?"

Grimcat frowned. "Mr. Administrator, I can't see that we're doing any such thing. We're minding our own business, keeping to ourselves, doing our best to help our own people. Hell, we don't want your pampered little toffs. They'd only be in the way."

Toffs? I wasn't sure what that meant, but I knew I didn't like it.

"Moreover, this trade's an absolute necessity for the people of Hole-In-The-Wall town," said Kawasaki-Jones. "Without it, we're never going to rise above bare-subsistence level. You should take that into consideration, Mr. Administrator. Desperate men are far more dangerous than peaceful traders."

He admits to being a runaway? A Reb?

"Is that a threat, Mr. Jones?" Dad inquired silkily.

"Not a bit. Simply stating the obvious." Kawasaki-Jones returned my stare with remarkable aplomb, not even pretending to lower his eyes.

He surely didn't look like a correctee. His fingernails were clean, for one thing, his clothes intact, not the slightest sign of desperation about him. Perhaps he was one of the few who'd left Ataraxia because they just didn't fit in.

"Also, I dispute this silly claim about 'contamination from other cultures'," said Mbinga. "You have UEMCo trade ships coming through your own spaceport once or twice a year, visiting professors from Earth, hordes of rich tourists, and I'd guess an occasional batch of new suck . . . uh, colonists."

Dad wore that politely-frosted look that wreaked such havoc on the psyches of Ataraxia's Board of Directors. "Everything we do is in harmony with nature. You, on the other hand, are exploiting our natural resources. And that's only a small part of it."

"Oh, horseshit!" Thaddeus O'Rourke leaned forward, his pleasant features twisted with disgust. "You know why we're here, and you don't even care! Colonel Daggs said you'd be this way, and I didn't believe him until now."

"Settle down, old buddy." Grimcat clapped one huge paw on his friend's shoulder, but O'Rourke remained tense.

The corner of Dad's mouth twitched. "Suppose you tell me why you're all here, Dr. Mbinga?"

"Well, it's pretty simple. The Yang epidemic's back. We have fifteen hundred new settlers, a third of them down with this bug. At least four hundred of them will die without the gum extract."

"How unfortunate that in all these years, you never bothered to learn how to synthesize it, let alone develop an immunization."

"Yes," said Mbinga drily. "And if we had the equipment—which we don't—why should we waste the resources when you don't *use* that part of the gum? The basis of your Tranquility dust is fractioned off at the highest boiling-point and salted out. You *throw away* the rest. Look, Rooster, you're cutting off your nose to spite your pretty face.

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Why won't you trade the gum for iron fertilizer and steel like we asked? We know how much GreenPlant and finished metal you're buying from UEMCo, and the prices they're charging you are insane."

I was getting more and more confused. Was Dad in radio communication with Elfour? How long had that been going on? Why wouldn't he help them against the very epidemic he'd risked his life to defeat in the first place, especially when we needed iron for our vegetables and steel for . . . well, just about everything?

A smile appeared on Dad's face, reminding me of stereos of himself as a young man. "Well, there may yet be a way we can do business together."

"How's that?"

"If you agree to take some of UEMCo's Terran transportees in lieu of payment to me. The percentages to be worked out, of course, but it could prove mutually profitable."

"Take slummers from the Planetary Renewal Project?" Mbinga looked incredulous. "We'd have to put it to a vote, but I can just about guarantee you it'd be no."

"That's one of the reasons the colony paid off UEMCo's investment early," said Grimcat. "So we wouldn't get stuck with PRPs in return for striking our debt."

O'Rourke sighed. "Yeah, but the new joes won't have their debt paid for three or four years yet. They'll scream."

"Let 'em. They can't vote 'til they're paid off."

"Look, this is all academic," said Mbinga. "We've got to get this extract home ASAP. We may not be back for a long time, so all this worrying you're doing about cultural contamination probably isn't worth the sweat. You got a lift-off tax in mind—what is it?"

Dad said nothing for a moment, but you could practically see the wheels turning. "How do I know you didn't bring the Yang bug here?"

"Because none of us came down with it in the three E-days it took us to jump here." The doctor smiled. "You must've known that, or you wouldn't be here with your son."

"Really, doctor, you ascribe too much knowledge to me. As for a lift-off tax, I require five hundred kilos of GreenPlant iron on your next trip, plus . . . oh, let's say a dozen escaped correctees."

"You want us to round up your runaways? On what grounds?"

"Disrupting harmony and theft. Take him, for example." Dad pointed to Kawasaki-Jones. "He ran away from my plantation sixteen years ago, taking one of my canteens and a brand-new set of breather gear. He still had six months to go on his sentence!"

Sundance's defiant expression was pure Reb. "And who gave me that sentence? An elected justice? Or a self-appointed god who can't bear public criticism?"

"The law is the law," Dad said, flicking his glance dismissively away from his erstwhile chattel. "Doctor, you must agree to turn over this man and eleven other runaways, or we have no deal."

Mbinga shook her head. "I'll give you eight hundred kilos of iron, but I won't be a slave-catcher."

"Those are the terms. If you won't cooperate, I can't allow you to depart. You leave me no choice."

"*We* leave you no choice?" Grimcat said. "Or is it UEMCo?"

Two red spots appeared on Dad's cheekbones. "This conference does not require the unsolicited remarks of a common crewman!"

"Yeah? Then clear the air your own self, Mr. Administrator, 'cause right now it smells like chickenshit."

"*What? How dare you. . . .!*"

"Wait!" said Kawasaki-Jones. "I'll turn myself in, if you'll let them leave with the gum extract."

Dad was shaking with anger. "And how do you propose to get me the other eleven runaways?"

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"Well . . . I could make an announcement in the square at Hole-In-The-Wall town. I'm sure others would come forward. The Elfourans are our partners; we've all got friends and relatives there."

The shocked silence was broken by the whirring of a communicator. Grimcat answered it, then handed it to Dr. Mbinga. "The lab."

She spoke a few syllables into it, then clicked off. "I've got to get back. Look, Sunny, there's no way we're going to. . . ."

"It's all settled," the Reb told her. "I'll go with the Administrator. You lift off on schedule. It's my choice, OK?"

The doctor looked hard at him, then Dad. "Is that agreeable to you?"

He shrugged. "It's fine with me if it produces the other eleven."

Frankly, I was amazed that Dad was as calm as he was after all this. Winning a concession didn't usually mean he'd resigned himself to anarchy. I burned to ask him about this business of communication with Elfour.

Everyone rose; the Elfour men shook hands with Kawasaki-Jones. "You're a *man*, brother. Thanks." None of them so much as glanced at Dad.

Dr. Mbinga opened the wooden door and went out, presumably to pick up her coat and blaster from the anteroom before leaving.

I felt confused. Dad had only been trying to get reimbursed for his own property. What was wrong with that? If the correctees didn't work on the plantation, how would they ever know they'd committed a crime? Did the Elfourans expect us to become common laborers, harvesting our own trees?

As we brushed past Grimcat, I heard him say to Thaddeus, " . . . run her out to the lab in the buggy. Hold down the fort for an hour, and maybe I'll let you pilot *Lady* to the jump point."

He wasn't a crewman, he was the pilot?

Ridiculous! Commander Ralston had to go to school for years and years to learn how to pilot a jump ship.

The jump point was a long way out—far enough away from the planet to keep the ship's Drive from getting all mixed up with our gravitational influence. I wasn't a GravDrive engineer, but even I knew piloting was a tad more complex than driving a kixed-up jeep.

Knowing how to fly through normal space was just the beginning. They had to be in the right place at the right time for the transition, or "jump point," because if they weren't, they wouldn't come out anywhere near where they plotted. (Making a wrong turn in hyperspace usually meant a one-way ticket to the wine-dark sea.) Of course all that math was programmed into the ship's computers, but a pilot still had to *know* it.

All you had to do was listen to Grimcat speak, and you'd know he had no formal education. (Regarding his final comment, I had no idea what a *fort* is, or why anyone would hold it down. Nor did I wish to.)

"Let me?" the black man echoed, grinning. "You just want to sleep the first leg, you piker!" Playfully, he punched the other man's arm with a hamlike fist.

It should have been sufficient to knock over a squadron of Guardia standing at attention like a stack of chessmen, but Grimcat simply chuckled as he strode out the door.

He had a machete on his belt, and I realized suddenly that he'd never taken it off. Maybe he'd forgotten it was there, but why hadn't McCann noticed it? We'd been at the Elfouran's mercy the whole time.

I opened my mouth to point it out to Dad, but one look at Dad's eyes—almost incandescent with anger—decided me against it.

But by the time we got outside, I couldn't contain myself. McCann walked ahead of us, his blaster pointed at the runaway, who held his hands over his head. "Dad?" I whispered. "When did they contact you about the iron?"

"Shut up," Dad snarled, flipping open

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his personal communicator. "Captain Cheney, this is *El Jefe*. Prepare for lift-off, condition three."

Condition three? "Dad, you can't destroy their ship, you said the deal was OK!"

"I said, shut up, damn you! You think I'd go along with this ludicrous charade? Asking runaways to come out pretty please—what nonsense! It's a trap! Arrogant bastards think I'd fall for . . ." His eyes widened in shock, and then he staggered two steps and collapsed.

McCann whirled and pulse-beamed someone behind me; a scream floated up on the air, surreal as the hole burnt in the back of Dad's head. It crossed my mind that he was dead, but I told myself to stop being so melodramatic. I mean, this was real life—it wasn't a play!

Only he wouldn't get up, though I pleaded with him, and he didn't curse me for being a fool. And then McCann fell, shrieking, a burn smoking half his face. A green pulse zinged my ear, crisping my long hair, and I was so frightened I ran behind *Implacable* instead of inside it. Kawasaki-Jones had disappeared, I didn't know where.

I heard a great shuddering boom, and the wind kicked up, whipping snow and pebbles from the ground. I peeked under the flyer's belly and saw the building collapse with awful majesty, engulfed in bright orange flames.

Should I try to rescue McCann first, and then Dad? McCann was closer and probably alive, but on the other hand, the medical people could surely resuscitate Dad, provided he hadn't lost too much of his . . .

As I dithered, four Guardia rushed out of *Implacable* and picked up Dad and McCann. Then they ran back in, all but one, who shouted, "*Oye!*" and fell off the gangplank. His body rolled under the flyer. It was Bobby Villa, Faerie's half-brother. The light had gone from his eyes—he was dead.

I heard the engine start up just as I saw two pairs of white-trousered legs flickering across the icy field toward the flyer. The Guardia wore dark-green trousers. Who were these white-clad men?

How could I get inside *Implacable* when the two doors are on the opposite side, facing them?

The engine sound increased in pitch; *Implacable* lurched forward.

In a panic, I ran forward too, waving my arms, but the flyer pulled ahead of me. When it became clear I couldn't catch up, and that no one on board saw me, I made for a nearby pile of rock and logs, expecting to be scorched at any moment.

The two men in white seemed preoccupied with the flyer, running after it and shooting at it with blaster rifles.

I ducked down and scurried behind the connecting piles of rock and dead branches. After a minute or so, I ran out of cover, and had to make a dash across an open meadow, beyond which lay a scrub forest. The meadow was maybe ten or fifteen meters, but looked as bare as Halcyon Beach at high tide. My ears were freezing; I pulled the jacket-hood over my head and ran.

And then a blaster-bolt hit me.

I awoke to find myself lying face-down on a slight slope in the meadow. I smelt burnt plastic and ozone, and my head hurt like insanity. My hood wouldn't come off—the polymer had melted to my hair.

I crawled toward the trees. I could still hear the *Implacable*'s engines overhead, so I knew I couldn't have been out for more than half a minute. Whoever had shot at me must've had his beam spread too wide or low on power, otherwise I'd be dead.

Why hadn't they come to finish me off? I couldn't think. I would've killed for a snort of 'Quil, but Dad made me leave the bottle in the flyer so I wouldn't offend the Elfourans.

When I reached the trees, I got up and ran. The forest thickened and I lost myself in it.

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Thoroughly.

When I could run no further, I collapsed onto a fallen tree, my lungs raw as a wound. An explosion shook the frigid grove. There was dead silence for an eon or two after it faded away.

And then a bird sang noisily somewhere in the forest, one of those mindlessly cheerful warbles. I tell you, I hated that bird. How could it be so happy when I was so miserable?

I was shaking and sweating at the same time, my hands and feet sopping wet. I wondered if this was worse than the time Alaric was killed. Since that part of my memory's a blank, I guess I'll never know.

Was this my fault? Would Dad have come here if he hadn't been so wound up about me being too lazy and irresponsible to make a good Administrator?

I didn't know the answers. All I knew was, I had to get home!

By yourself, down this mountain and through sixty kilometers of rainforest, without a machete or even a breather mask?

Uselessness is vrill.

Tears froze on my cheeks. Where could I go? The people of Hole-In-The-Wall wouldn't help. They were probably responsible for the attack, though I didn't doubt that the original barbarian, Colonel Daggs, was in on it.

Then I remembered the personal flyers on the rocket-field. If I stole one of those, I could fly most of the way home.

I hadn't flown one since Alaric was killed. The thought of encountering a quetzalcoatl made me feel sick enough to upchuck my socks, but how else could I get home? I'd need to have a breather mask for the rest of the trip, and be extra careful I didn't injure myself landing, but . . . well, I could do it. If I had to.

I punched the "local enviro" button on my watch. Three hours 'til dark. If I hurried—if the attackers were gone, and I found at least one fresh breather mask—I could spend tonight in a nice warm rainforest. Once I made it down to the ground and found the road, I'd have little worry about *bocas*, boojums, or quetzalcoatls. Just Colonel Daggs and his ilk . . .

My heart quailed. The play and the dance seemed a million klicks away. Maybe Dad and McCann were already revived, or would be shortly. They'd order the Guardia to find me and be quick about it, but for now I'd have to stick to this plan.

I looked around. Which direction had I come from? Little snow survived under these scrawny wind-blown trees, and I saw no trace of my passage on the leaf-covered ground.

I raised my eyes to the sky, and saw a black haze that I realized must be smoke from the burning spaceport. Had that last explosion been Daggs' ship?

Dad had ordered the Guardia to blow it up. I jumped to my feet, exultant, until I remembered all the sick people back on Elfour who wouldn't get their medicine now. I told myself the attack was partly their fault, but then I got all mixed up trying to figure out how.

I headed toward the smoke, wondering if my head was bleeding under the melted plastic, and what would happen if Dad was dead. I knew he couldn't be, but I'd gotten stuck on one of those obsessive-thinking loops my HealthMon always warned me about.

Would we be at war with Elfour? If so, the barbarians would have the advantage. We were clustered in a single city, easily attacked. I suspected they'd spread out—their air was breathable anywhere, and they were too quarrelsome to live together as we did.

If Ataraxia were attacked, what would happen to Faerie? And Booter? And Summer and all the other kids? I moaned. All the wargames I'd played, and I had no clue how to save the people I cared about.

I forgot to look up at the smoke for a few minutes, and then when I looked at

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it again, it was off to my left. Scowling, I changed course.

My head throbbed hideously. Despite pain that would have felled a lesser man, I would push on to find Dad, and if worst came to worst, lead a ragtag band of civilized norms against the barbarian horde. . . .

An image of Faerie's adorable self appeared before me like a holo. She's presenting me with a medal for saving the city. Her eyes are like twin pools, her brows as delicate as the nectar-feeding zephyrwing, her . . .

Presently I became aware of a rumbling sound behind me. The ground was smoother, so it was easy to walk faster. *The Guardia must be blowing up Hole-In-The-Wall.*

But wait, wasn't the town ahead of me, near the spaceport?

I turned and saw the boxy outline of an aluminum Jeep approaching, like one I saw parked in front of the conference building, only . . .

Dr. Mbinga was driving. I ran, but a thousand fingers caught me, and I hit the ground like a ripe peach.

The next time I awoke, I was Tanglewebbed in the back of the Jeep. Being webbed up certainly makes you forget about your other little problems.

"Hey!" I shouted to the back of Dr. Mbinga's head. "If you know what's good for you, you'll let me go. I'll have you arrested for kidnapping."

She whipped into a turn, tires spinning gravel. Like most aluminum vehicles with bad drivers, the Jeep slid all the way across the road and fetched up in a ditch. "I kidnapped you for a good reason, sonnyboy. I need a hostage for my gum."

Gears clashing, we rebounded out of the ditch and flew at breakneck speed down the side of the mountain. The panorama dizzied me: twisty white-clay road, soy-milk clouds, rocky heights plunging to a dim red-gold fog of rainforest kilometers below.

"You need what?" I didn't shout this time. It made my head hurt worse, and I was afraid she'd slide right off the road.

"A hostage for my gum. Since your daddy destroyed our ship, and the lab with most of my extract, I figure you're poetic justice. Swapping you's easier than shooting up the place—not that I got anything against doing that if I have to. I'll even take a look at your head, soon's we get far enough away."

"Don't bother," I said rudely. "I don't want any help from a murderer." A knee slammed painfully against my leg, reminding me that I shared the back seat with someone who lay slumped across most of it with his head resting on the door.

In the twilight, it took me a few seconds to recognize Grimcat with that brown cloth wrapped around his head. He was either asleep or unconscious.

Mbinga threw her shoulders into another turn—the kind we call turn-and-return. The Jeep fishtailed. "Oh? We sure as Hell didn't attack our own base. Damn Sundance anyhow! I told him we needed a full perimeter of round-the-clock sentries, and he swore up and down that we had it. If your Guardia had brains enough to pour sand out of a boot, we'd still have won."

I swallowed nausea and stared at the horizon, where *Sangrón* gleamed like a malevolent eye. "I don't know what you're talking about. You started it by shooting my dad!"

Mbinga swerved, missing a fallen boulder by centimeters. "Can't say he didn't deserve shooting, but I didn't do it, and neither did Grimmo. Those boys in white camos look like your best candidates, but I don't know who they were. They were too busy shooting at us to stop and identify themselves."

I uttered an obscenity.

"Suit yourself." The doctor switched on the com unit. Static rattled like hail on a tile roof, then vanished. "This is Dr. Mbinga from *Lady Liberty*, calling any Elfour ship. Mayday!"

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After a minute or so of that with no response, I said, "I'm thirsty and hungry. The least you can do is give me a drink of water."

She stopped the Jeep and held a canteen for me, though she looked as if she'd gladly dump it over my head. I leaned wearily against the door, glad for Grimcat's warmth and the liquid trickling through my parched tissues.

Through the broken window, I saw the vast purple sky raining diamond stars, extinguishing the bloody flame of the sun. In the distance a quetzalcoatl shrieked its eerie up-and-down call, so wild and lonely it made me shiver.

Holding a clone hostage. It was hilarious, but I couldn't laugh. Since Dad placed no value on extracted gum, I supposed he wouldn't mind trading it in for me.

The com unit sputtered. "Leslie, this is Jack. What the Hell happened down there?"

I fought to stay awake, but I faded out about the time he said he'd send another ship.

It was a long night. They usually are—the days are fifty-nine hours long, so at Midsummer, it's dark about fourteen hours. I didn't wake when she cut the hood off my head, but the wound-cleaning was a different story. And later I woke when she put a breather mask over my nose.

Some time after that, the Jeep broke down. I had a hard time believing it was from a mechanical failure rather than an impact, but I think I would've known if we hit something.

"Time to get up, boy!"

I opened my eyes. Still dark, but the green of early dawn painted my surroundings with ghostly outlines. I was in the back of the Jeep, parked slantwise on the road—somewhere near the bottom of the mountain, I guessed. Long strands of creeper-flower wove a silvery tunnel above my head.

The air was cool, but normally so, the sweet green tree-scent redolent with the promise of a hot day ahead. I can't tell you how grateful I was for it. I never wanted to be cold again.

Dr. Mbinga tossed me a canteen, and something wrapped in shiny paper. I made a grab for them, and realized suddenly that my Tangleweb was gone—from my arms, at least. Since I hate eating in a breather mask, I took it off, figuring I couldn't get a worse headache from CO_2 than what I had already.

The shiny paper actually *crinkled*. "Hey!" I said. "Is this metal?"

"Aluminum foil."

Tranq, what wealth! It took twenty kilowatt-hours of electricity to produce one kilogram of aluminum. That was about the only metal we had in quantity, and we didn't waste it on food-wrap.

"That brown blob inside is breakfast," she added. "Just hold it in your hand, add a little water, and squeeze."

I did so. It still looked like an ugly thumb-sized brown blob, too small for an appetizer, let alone breakfast. "What is it?"

"Pemmican."

"Never heard of it."

"Emergency rations. Drink water afterwards, and it'll expand in your stomach like a full meal."

Maybe a Bonier's croc would've regarded it as a delicacy. I washed down the weird-tasting concoction with canteen water, wishing for gingorang juice, or at least some kefir to clean out the toxins.

"How're you feeling?" said the doctor.

"Terrible, no thanks to your friends."

A grizzled eyebrow quirked, herding stray wrinkles into the center of her forehead. "I think you need to do a little thinking about *your* friends, sonnyboy."

I ducked my head, making a show of checking my mask's sodalime absorption indicator. I didn't want to remember the plane taking off so quick without me. It hurt, knowing how easily I could be replaced.

"Why do you keep calling me sonnyboy?" I said.

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"You remind me of my great-grandson, Malachi."

"How many kids do you have?"

"Seven. Plus five grandsons and three great-grandsons."

A one-woman breeding program. Colonel Daggs probably forced her and the other women to have as many kids as possible.

My indicator showed blue, which I usually regarded as plenty of absorption time. But how much was that, maybe half a day? If we were where I thought, I didn't think I could walk to the plantation in that amount of time. "Do you have any more masks?"

"No. Yours came from the Jeep's emergency kit. I had to clean out my pack to make room for my bottles of extract, so I don't have any more."

Well, maybe we could make it in time. If not, we'd get cyanotic and maybe develop congestive heart failure, but there wasn't anything I could do about that, was there? I slipped the mask back on. "Where's Grimcat?"

"Under the Jeep."

Leaning out the window, I saw a white semi-circle of flashlight, bisected by a pair of legs sticking out from underneath the front part of the vehicle.

Shortly the rest of Grimcat appeared. His head bandage was gone, but his right forearm was wrapped in a makeshift splint, and he moved slowly—for him. "I don't have the parts to fix the cussed thing." He went on to describe the Jeep's designer in bewilderingly detailed invective, centering around the conclusion that anyone who did so must have his family tree liberally cluttered with ancestors of the cloven-hoof persuasion, and finished with, "It's a miracle it ran at all."

"Now, don't go getting your blood pressure up over something that can't be helped." Mbinga handed him a canteen and a couple of white tablets. "*You* won't be running much further without a little assistance. Take these."

He made a face. "I don't need any medicine. Feels like my last Corncob Wine hangover, that's all."

"When you passed out in the corral, and Bluebell kicked you in the head?"

The redhead nodded glumly.

"Take 'em," advised the doctor. "You don't know how lucky you are to be alive."

"I do know. Sometimes Lady Luck kisses you on the lips afore she screws you." Nevertheless, he swigged down the pills, and as he did so, he looked me over with bloodshot eyes. From the expression on his face, he wasn't particularly pleased with what he saw. "Well, Rafe, does this road go through to your city?"

I shook my head sullenly. If I'd gotten my hands on a flyer, I'd be there by now, or almost. "It used to, but nobody kept it up. Most of it's overgrown now."

"Then we cut through the bush." Grimcat looked in the back of the Jeep. "Muddy Hell, what happened to my hat?"

"It fell off when I was hauling you onto the Jeep," said Mbinga dryly. "I was in a bit of a hurry, what with all the fireworks. Frankly, I thought you'd be more concerned about the loss of your blaster."

"I still got my knife and machete. But losing my hat . . ."

"Cutting through the bush's dangerous!" I burst out. "We could be attacked by a *boca*, a quetzalcoatl, or even a spotted boojum!"

A line appeared between the Elfour man's thick brows. "The boojum won't bother you unless you get between her and her kits or food-cache. As for the quetzalcoatl, it's only a problem in the open, where it can dive on you. I'll keep a sharp eye out for *bocas*, don't fret. They're mighty good eating."

"*Eating?* Tranq, you people are barbarians!"

The corners of Grimcat's mouth turned up, and a sound issued from his chest like the rumbling of thunder. It took me a moment to realize it was

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laughter. "No more than you podheads eating chicken and fish. And what about that bug you all are so fond of—you still eat that sucker on holidays?"

"The *langosta* is *not* an insect," I began heatedly. "Only an ignoramus would . . ."

"Quiet, both of you," said Mbinga. "We've got more important things to discuss. Grimmo, I know you and your daddy mapped most of this planet, but you don't have any instruments. The map in the Jeep is just of these mountains and surrounding jungle. If the road's gone, how do we get through all this jungle without losing our way?"

"Simple." He picked up several light-colored stones and piled them in a straight line. "This points to the Toad-Sticker." He indicated a dagger-shape of faint stars, still visible just above the horizon. Actually, we called it the Dagger. The faint star in the tip lies near true north.

"I know what the Toad-Sticker looks like," the doctor said grumpily. "I just can't get used to it being so close to the horizon at this time of year."

"That's because we got more axial tilt," Grimcat said. "Anyway, it don't matter. Ataraxia's that way, about sixty klicks to the northwest. But we won't go straight there—terrain's so rugged it ain't worth it." With a stick, he drew two lines in the dirt, the first inclined north-northwest, the second growing horizontally out of it. "So we'll head for this river, maybe forty klicks from here. Once you get through the bush into the jungle, there's practically no undergrowth. The terrain's an easy downward slope, plus I can always climb a tree and sight off Bignose Peak, and the volcanoes of Isla Vista. After we hit the river, we turn west and follow it on down. The city sets on a hill above where the river dumps into the bay. Easy as catchin' chucks in a barrel."

"Perhaps," said the doctor drily. "I'm beginning to be glad I brought my Harrison." She held up a skinny wrist, displaying the fancy "watch" I'd noticed earlier. "I programmed the directional for true north. I hate getting lost."

The Elfour man grunted. "That's cheating. But suit yourself—you know I'll get us there if your gadget breaks."

"I like gadgets. I'm setting it for north-northwest."

"Fine by me."

"Say, your father was Hugh Smith?" I blurted.

Grimcat nodded. His manner was matter-of-fact, as if I'd just asked him the time of day. And here I'd been arguing with him, calling him an ignoramous!

Hugh Smith was much more famous than my father. He'd been the greatest explorer ever, mapping eleven worlds before he disappeared on Hobson's Choice. Since the League's rules are that you can't colonize a world with sentient inhabitants, his claim that there had been intelligent life here had been a real sore point with Dad. "Uh, how did he ever resolve his claim of finding sentient native life here?"

The Elfour man unplugged the small computing and communications unit from the Jeep console and stuffed it in a carry sack. "He found an *artifact*. Along with a couple pieces of worked metal. That don't necessarily prove sentience, or that the folks who made it originated here, which's why he didn't claim that."

I felt something curl about my arm and slapped it away. A creeperflower. "But surely you agree that if there were any artifacts to be found, we Ataraxians would have found some?"

"You can't find 'em if you won't look. Muddy Hell, you think they come with a little sign, 'Aliens was here'?"

The blood rose to my face. "You can't speak to me like that. I don't care how influential your family is, it simply isn't done."

"I'll speak to you however I please. You're the prisoner here, and don't you forget it. I'm halfway inclined to whip your sassy butt, even with my arm broke."

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I was speechless. Lay his hand on me? How dare he!

"C'mon, boys," the doctor said, slinging her backpack and canteen. "The sooner we start walking, the sooner we get there."

I refused to help with the leaf-cutting. If Grimcat wanted to risk our lives dragging us through the bush, let him do it himself.

Even hurt as he was, using his left hand, he was stronger than any four correctees I'd ever seen. He also had a knack for picking trails with the least creeperflower, which can slow you down or even trap you if you're not careful.

It irritated me that he handled himself so well on "my" planet. Well, it was my planet, wasn't it? Dad wasn't going to let anyone else be Administrator. His assistant, Brad Pfeiffer, certainly wasn't up to the job.

I swept the bush with my eyes, studying it for the least sign of *bocas* and boojums. I didn't see any. Remembering the phrases "pampered little toff" and "podheads" only made me madder. I'd show that *crudo* barbarian!

The vines grew thicker; the temperature hotter. I pushed on stolidly, despite my injuries. Grimcat stuffed his shirt in the carry-sack tied at his waist, exposing a physique that women would happily claw one another for. My jealousy grew as I thought of Faerie's reaction.

"Hand me the machete!" I demanded.

"I dunno," Grimcat smiled. "You might try to overwhelm me and escape."

"I would never attempt such a cowardly act," I said with dignity. Mainly because it'd never work—he could flatten me one-handed.

"I'll take your word." He spoke the sentence with curious formality.

My shoulder tired quickly, but he showed me how to rest a bit on the downswing. When my muscles screamed for relief, I switched to my other arm. It seemed like hours I did this, but my watch said it'd been only twelve minutes when I cut through the last of the vines and we stepped into the rainforest.

Dr. Mbinga clapped her hands in delight. "How beautiful!"

Delicate blue and lavender titanwood trees soared a hundred and fifty meters above our heads, their slender red and gold leaves whispering softly in the breeze. Purple and white Godflowers drifted in the air with no visible means of support, thousands of lacy foglike tendrils questing for nutrients. Thick, twisted tree roots seemed to ripple the ground, which was covered in a smooth carpet of silver and gold mosses, dotted here and there with rings of pink "mushrooms" that came up to my collarbone.

Nine or ten meters in diameter at the base, titanwood looks as if it might snap in the next wind, but it's harder than Terran ironwood, and much lighter, too. The mushrooms are fungi, just like on Terra, though much bigger. There's also a plant that looks like a mushroom, but traps and eats small animals.

To my relief, the doctor insisted we rest now, so I dropped the machete and threw myself down on the moss. I felt good. I was pouring sweat, but right then I didn't care if I had a shower or not.

I breathed in the heady perfume of crushed *musgo* and mating Godflower, and saw a flash of brilliant green way overhead as a flock of esmeralda skates fluttered through a sunbeam.

The two Elfourans lounged nearby, looking about as tired as I would after a stroll to the kitchen. Grimcat pulled off his boots, turned them inside-out, and put them back on again, tying them around his shins with thick strings.

This footwear was fashioned from some blue-gray material, thick and glossy as fur. Not vrill, but it had a sporty charm that intrigued me. "What kind of boots are those?"

"They ain't boots; they're moccasins."

"Moccasins." I rolled the word around

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on my tongue. "May I ask what they're made from?"

"Marl's-hide."

"Animal skin?" I didn't even try to conceal my revulsion. "Don't you cultivate any usable plant fibers?"

"None so warm as this, or cool inside-out. Face it, sonnyboy, these here trees'll make mulch out of you after you're dead, and some won't wait that long. Ain't no decent burials in the animal kingdom." Smiling, Grimcat rose. "Let's go. We rested enough last night."

"Wait a sec," said Dr. Mbinga. "I want to check his wound first."

I didn't much feel like getting poked at, but I sure didn't feel like getting up right now, either. "Ow!" I jerked away from her probing fingers. "That hurts!"

"Hard to see with these bits of plastic in the way." She found a square of antiseptic in her backpack, and placed it on the side of my head, where it melted, stinging and bubbling, into the wound. "I can't get rid of them unless I cut the hair off."

I glanced through pain-squinted eyes at Grimcat. He stood leaning against a tree-trunk, cleaning his nails with a knife. I knew what he was thinking, that a pampered little toff like me would die before he'd cut his pretty hair.

"Cut it," I said.

She ended up cutting off practically all my hair. Instead of being down to my shoulder blades, it was now maybe four centimeters long, about the same length as his. I hadn't had it this short since I was a babe.

"Now we're gonna pick up the pace," Grimcat said, sheathing his knife.

"Why are you in such a hurry?" I inquired. "Do you have a rendezvous with the other ship?"

"You might say that."

"Where'd you get another ship? I thought you had just the one."

"Lotsa things you don't know about us."

I must say, conversation with him was not particularly illuminating. The next few hours were too excruciating to focus on my questions, or I might have attempted to draw out the doctor (who seemed marginally more amenable).

Even she, old and frail and carrying a backpack, had no trouble keeping up with Grimcat. I was breathing hard inside of ten minutes. If anything convinced me I couldn't run away from them, this was it.

Grimcat behaved as if we were on an ordinary hike, pointing out the best route around fallen trees, which mushrooms were edible, the preparation and use of titanwood bark as a mental stimulant, etc. Apparently he was one of those beastly individuals whose moods are improved by physical activity.

"I thought you Elfourans . . . didn't approve of drugs," I gasped.

"Which drugs? We don't have any use for the HeavenSent trade, that's for damn sure."

"What's HeavenSent?"

"Don't tell me you don't know."

"Well, I don't!"

"It's your Dust with a couple of them high-braincell-affinity acetyl groups stuck on it. The Right-Hand-of-Gods on Terra live on that stuff. They'll do anything, pay every penny they got for a couple grams a day. After four or five years, they get so they don't care 'bout food no more, and they starve to death."

I'd heard whispered comments that hadn't made sense. . . . "Is UEMCo selling it to them illegally?"

Grimcat whooped with laughter.

"What's so funny?"

"'Course it's illegal on the face of it, but since UEMCo's government-owned, ain't nothing they do is really illegal. That's just to keep the price up and the competition out, which's how your Dad financed your pretty little Utopia. He made UEMCo stinkin' rich, and they're right mad at him for not keepin' up with demand."

Was that why Dad made me leave my Dust in the flyer, so no one would men-

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tion this to me? Or maybe Grimcat was trying to trick me . . . but to what purpose? I could not think of any. They were going to trade me in, not keep me.

Why hadn't Dad mentioned this before? I felt a flash of self-anger. If I'd paid more attention to the accounts, I wouldn't need him to tell me, I'd've found out for myself.

The Elfourans slowed to let me rest, then picked up the pace again. We spent half the quarter-day morning on this wretched marathon. By the time we got to the river, I was dying to rest and eat lunch. But no, Grimcat insisted on going all the way to Dragon Falls first, and the doctor didn't attempt to dissuade him.

Frankly, I thought it indicated malpractice on her part. *For Tranq's sake, I was wounded*! I considered telling them to carry me if they wanted to go on that bad. Something—stubborn pride, I suppose—silenced me. The growing rumble of falling water drew me on.

We came 'round a bend in the river and there it was—tons of white water flinging itself off a cliff sixty meters high onto the slick gray rocks below, spume boiling up like fine smoke. Dozens of rocky pools cascaded down from there, ranging from big foam-bedecked whirlpools to tranquil kid-sized, very *artístico* with red waterflowers and gold leaves. The greenish-blue sky reflecting on the water made it look clear as glass.

On the opposite shore, a gray dragon raised a weed-bedecked muzzle, stared at us, then lumbered away with a flick of its spiked tail.

"It's just like I remember it," Grimcat shouted happily. "I was just a bitty kid when I first saw this place."

"Pretty." Mbinga shaded her eyes with a hand. "What just ran off?"

"A dragon," I said. Had Grimcat's dad really taken him exploring? I felt dizzy with jealousy. Dad never took me anywhere that he hadn't already conquered. Why wouldn't he ever let me do anything *new*?

"I thought dragons had wings and scales and ate meat."

I shrugged. "Well, Dad's name means 'dragon', and when he saw that creature, it just seemed like the natural thing to call it."

"Just seemed natural to call this Dragon Falls, too, eh?"

"It sounds better than Smith Falls," I retorted, stung.

Grimcat nodded. "That it does. Daddy called it Morella's Plumes, for my ma. He said the mist reminded him of her hair."

Such a romantic sentiment coming from that legendary iron man boggled my mind. I couldn't imagine Dad naming anything after Tirali's hair. It just wouldn't occur to him, and besides, she changed its color every ten-day.

The breeze from the water was wonderfully refreshing, but I wasn't tempted to go swimming. This wasn't prime quetzalcoatl real estate, like the limestone cliffs, but the creatures often supplemented their diet with unwary animals attracted by the water.

Shuddering, I collapsed under the nearest tree, then wadded up Dad's blue-lined shirt for use as a pillow. My gold under-tunic was soaked, but I felt disinclined to remove it.

We were out of pemmican, and I'd reached the point where I didn't care if I ate, just so long as I could lie down. My feet throbbed in concert with my head, and my calves continued to quiver despite blessed immobility on my part.

Grimcat returned from his food-search in what seemed like no time at all, his shirt bulging with three sunberries, each half the size of my head, and several smelly black lumps that turned out to be ripe *nuez*-nuts.

We all took off our masks to eat. I noticed that mine was more than three-quarters gone, but saw no point in mentioning it. They could read an indicator. Besides, they both shook their masks—it rolls the sodalime around, so you get

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the maximum surface area exposure. They knew we were getting low.

"You'd think there'd be a road near here," Mbinga said, peeling off a sunberry section and popping it in her mouth.

"There is," I said, cracking a nut with a rock and brushing away dirt. "On the other side of the river, but it's all overgrown."

"Don't get out and see the country much, do you?"

"I prefer to stay home." Avoiding her eyes, I tore into my berry.

"On a beautiful planet like this? That seems a shame. Once my boys were walking, the only time they came home was suppertime."

"That's 'cause you made 'em work out in the fields all day," Grimcat said with a smile. "Plowing forty acres with a mule takes considerable time."

I was appalled. *Her own children worked the fields like correctees*? No, worse than that—we never made correctees partner with animals to till the soil.

Mbinga got a far-off look in her eyes. "Oh, they always seemed to find time aplenty to go hunting, or hang around the spaceport with tall-taling spacers. Gods, how I miss those days!"

Grimcat patted her hand. "Me, too, honey."

I tell you, nothing about them surprised me more than this lapse into sentimentality. She *missed* those days—bearing seven children into such a grueling existence as that? How could any woman in her right mind feel that way?

"So where's all the animal life?" The doctor glanced around curiously.

"It's here." Grimcat cracked a nut between his strong teeth. "Pretty sluggish compared to ours. Hemoglobin's based on copper, 'stead of iron. The quetzalcoatl's got the best energy utilization—it stores oxygen in muscle for later, even digests oxygen from its prey. The CO_2 doesn't seem to bother it. Other predators lay up, and don't move 'til they need to." He pointed to a stout branch on a nearby titanwood, about seventy meters above the ground. "See anything up there?"

I strained my eyes. I'd decided there wasn't anything up there but Godflowers and God when the globular shape suddenly leaped out at me. "A *boca*!"

"Shouldn't we move?" said Mbinga worriedly.

Grimcat shook his head. "He knows if he fell on one of us from that height, he'd be in a world of hurt. Plus, he's too small—never get us digested before something else got him."

"Why didn't I see him earlier?" I cried. "I was looking right at him!"

"You was tryin' too hard," the redhead said simply. "You look too hard, you can't see anything."

That worried me. If I hadn't seen the *boca* for that long, what else wasn't I seeing?

Off and on, I'd tried to sort out what happened at the spaceport, but maybe I'd been trying too hard on that, too. It's difficult to concentrate when your immediate future's in jeopardy.

Dr. Mbinga had her blaster, so I supposed she would— what—hold me hostage once we arrived at the Guardia station? (She'd probably exhausted its charge during the fight, but I was not inclined to test that theory.) Then someone, presumably Brett, would hand over so many kilos of gum, and then Grimcat and Mbinga would leave on this other ship. In the best-case scenario, that'd be the last I'd see of them.

Worst case, Colonel Daggs could pull a double-cross and kidnap me, even kill me.

And then what? Either the Guardia would rescue me or not, and the Elfourans would release me or not. If Dad lived, I'd have to carry on the HeavenSent trade to keep Ataraxia going until he recovered; if not, I'd have to do the same thing, so I'd have the resources to punish his killers. Unless I agreed to the iron-plankton project. Whatever hap-

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pened, I didn't seem to have any more choice about things than a prize hen.

How much debt had we incurred? *Where* would we get the metal we needed, and the vitamins and iron supplements, if not from UEMCo? We had an exclusive contract with them; we never used non-UEMCo sources. I scowled. I didn't care about those stupid Right-Hand-of-Godders! If they didn't kill themselves with HeavenSent, they'd do it some other way.

An hour after we left the falls, the fragrance of flowers and spices told me we were nearing home.

"I smell cinnamon," the doctor said. "And cardamom! When I was a little girl back on Earth, my mama used to make spiced yellow rice. . . ."

"That's our plantation," I said proudly. "We grow Earth spices, but they're all much bigger than the original rootstock. Our prize vanilla beans run over two meters long."

"Think of that!" Mbinga shook her head.

"You're welcome to one, if you like. They're wonderful for baking."

"Keep your muddy beans," Grimcat cut in before she could reply. "This ain't a cooking expedition."

He needn't be so Tranq-be-damned rude! One of those beans was worth hundreds of credits on Earth.

Presently we came across the thorn fence, which kept out the dragons. Grimcat made short work of it with his machete, and not long after that he spotted Harmony plant roots—the only part you can see from the forest floor. "Mark it, Leslie! *Xenopos patelii*."

"I don't see any flowers," said the doctor. "Just tree-trunks."

"The flowers're on top o' the canopy. They're parasites. Rain washes nutrients from the titanwood bark into the roots, which attach to the tree-trunks."

"So that's why you use flyers to harvest the gum."

"Right. Here, the slaves get to do it the hard way—climb all the way to the top and slash the pods with machetes. Couple days later, they come back and scrape off the gum."

Bile rose in my throat. "They're not slaves! They're correctees, working off their debt to society."

Grimcat just stared at me with his spooky gray eyes. Wide and unblinking like a boojum's when he first sees you, without a trace of human kindness or compassion. "Now, that raises an interesting question. What's a slave? Seems to me you Ataraxians're mighty dependent on these folks raising your vegetables and your dope. If they all ran away at once, you might starve. Where I come from, we call that dependency slavery. I'll admit it might be more accurate to call you a parasite, like your prize plant."

Tears of impotent fury filled my eyes. "I've never met anyone as horrible as you. I hope the Guardia shoots you dead!"

"Plenty of folks've tried." The Elfouran glanced at his watch, then opened his carry-sack and switched on the com unit. "Jack, this is Grimmo. Do you read me, Jack?"

I slumped down on a hassock-sized mushroom with my head in my hands. I'd never been so exhausted in my entire life. I wanted to throw up, then lie down and sleep for a ten-day. It occurred to me that the stale taste of the air meant that my mask's absorption capacity was about gone, but I couldn't seem to get too concerned about it.

Dr. Mbinga put her hand on my forehead. "Don't pick on him, Grimmo—he's just a boy, and burning up with fever."

Tirali never touched me like this. She hates being around sick people. My HealthMon's bio-plate reader wasn't anything like a nice cool hand on your forehead.

"Terrans ain't gonna treat him like a boy. They'll treat him like a man grown."

"I feel like I'm dying," I said miserably.

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"You don't happen to have any 'Quil Dust, do you?"

"No, just the extract." She plunked down next to me and hauled me onto her lap like I was one of her kids. "It'll pass, honey. You'll see—everything'll be all right."

Her blaster bumped square against my hipbone, and I suppose if I'd thought about it, I'd've grabbed it and run off. I mean, this was my chance to escape!

Only I didn't want to. I could've stayed in her lap forever, listening to her quavery old voice crooning assurances in my ear.

The com unit crackled noisily. "Grimmo, this is Jack. Do you read me?"

"Roger, Colonel. Damn, but it's good to hear your voice!"

"Ditto. I pinpoint your location about three klicks south-east of the landing pad. The gum's already on the shuttle there, and you're cleared for take-off."

"You took care of the local sheriff?"

A masculine chuckle. "Let's say *Tom Paine*'s guns are giving him the evil eye. Those boys aren't going anywhere without our say-so. Isn't that right, Commander Ralston?"

"That is correct, sir." I recognized Ralston's voice. He didn't sound happy.

"Grimmo, it's all set. You and Leslie drop off the kid, and scram up here in the shuttle. They know you're coming, and they also know that if they harm a hair on your heads, their precious boat gets to orbit this planet in a million and one pieces."

Drop off the kid? So he wasn't planning to kidnap me.

"Colonel, I'd welcome that like two blankets on a cold night. I'll need you to squirt me your orbital parameters."

"Roger."

I craned my neck a few seconds later, and saw the green *received* light blinking in the com unit display's upper left-hand corner. Grimcat copied the information into Dr. Mbinga's Harrison ("for luck," he said), then shut off the device and replaced it in the sack.

Realization sank into my bones like ice crystals, and I shivered despite the heat. "It was UEMCo who attacked your base, wasn't it? They assassinated my dad, figuring you'd get the blame. Now they've taken over Ataraxia."

Mbinga nodded. Her brown eyes looked sadder than any I'd ever seen, their expression multiplied a hundredfold by her wrinkles.

"So you were just going to hand me over to UEMCo and let them kill me?" I shouted, jumping up.

"Oh, I don't reckon they'll kill you," Grimcat said, taking his mask off and peering inside. He shook it, but instead of sliding it back on right away, left it dangling from his massive fingers. "Someone's gotta show these birds how to run the plantation. Smart young fella could make himself almighty valuable in no time. Just don't rub nobody important the wrong way, and don't show no ambition. That last part is what'll get you killed."

"But I *have* ambition. I don't want to be valuable to them! This isn't *right*!"

"What you want don't amount to a hill o' beans. Sorry, Rafe, but that's just the way it is."

"Wait a minute!" said Mbinga. "Jack said the shuttle's ready and waiting for us. Why can't we take sonnyboy with us?"

"'Cause I ain't got time to babysit." Grimcat scratched his beard meditatively. "I wouldn't mind spitin' them bastards after what they did to *Lady*, not to mention poor Thaddeus, but we got too many folks depending on us. C'mon."

The doctor gave me another sorrowful look, and gestured for me to go ahead of her. Filled with bitterness, I complied.

"Grimmo, have you checked your indicator lately?" Mbinga's voice sounded tired.

He did so, then tossed his mask away. "Played out. Well, I'll be fine for a couple hours without it. More'n enough."

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"You're already starting to hyperventilate. If you lose your balance with that bad arm . . ."

"Oh, hush up, Leslie. You know as well as I do that I ain't the one to worry about on that cliff. It's you."

"Me? Why, I was climbing rocks bigger'n that while you were in swaddling clothes. Seems to me you said there's a nice open spot near there. How 'bout you stay there, and I fly the shuttle back to pick you . . ."

"I'll be fricasseed in muddy Hell afore I stay behind! Now, look, Leslie, it stands to reason you oughta be the one to rest up on that flat spot, while I . . ."

"This discussion is unnecessary," I interrupted smoothly. "The bridge can't be more than a half-kilometer ahead, and it'll put us directly on the road to the main guardshack. The Guardia will give us a ride up to the shuttle launchpad. There's no reason to go anywhere near the cliff."

"Don't be an idiot," Grimcat snapped. "I ain't sashayin' into no guardshack and askin' 'em to haul my tired butt to the launchpad. Your Guardia's loyal to UEMCo now, not you. We're taking the side way up and around the cliff, through the cave in the hill, and out the other side."

"You're crazy if you think we can rock-climb without masks! Not to mention the fact that DisEquilibrium Cave's off-limits. Dad boarded it up years ago because of the quetzalcoatls . . . the Guardia leaves them up there as a threat to keep the plantation workers from escaping." I appealed to Mbinga. "Doctor, surely you can tell he's hypoxic—unfit to command!"

She shrugged. "We do, or we die. There's no other way."

"I don't care if God and the Three Ladies roped the place off, we're going." Grimcat seized me by the wrist and began dragging me up the slope, muttering something about how only ignorant PRPs were scared of signs and birds.

I swung on him with all my strength, with no effect but injuring my hand. "I saw my best friend killed by one of those 'birds'!" I said, my voice cracking with emotion. "Right where you propose to go! You don't care how much disharmony I suffer, do you?"

Metal glinted in Grimcat's eyes, or so it seemed to me. "Son, everybody suffers disharmony. You ain't gonna believe this, but pain's good. It tells you something's wrong, so at least you stand a chance of fixin' it. I just lost a good friend back there, and the best ship a man ever had. I ain't gonna forget 'em. But when you do your muddy damnedest to save 'em, and lose 'em anyway, that's Fate. When She's got the bit in Her teeth, none of us can turn Her, any more'n we can turn the stars."

He sighed. "I'm sorry, Rafe. But there ain't no better way to that launchpad. Unless I get an ironclad guarantee that General Pennick's a logical man who knows when he's licked, I ain't bettin' my people's lives on his reasonableness and goodwill. Even then, I wouldn't believe it."

"Who's General Pennick?"

"The new military governor of Ataraxia." Grimcat released me, and I staggered back, rubbing my wrist. "You gonna behave now?"

"Yes," I said dully. All I could think of was Dad on the ground with a hole in his skull. Like I'd almost had in mine. Had General Pennick ordered Dad's death?

"Good. Leslie, you're getting a ride up to the cliff." The doctor opened her mouth to protest, but Grimcat scooped her up in a flash, straightening up with her balanced on his left shoulder.

"Put me down! I do not need to be carried like a child!"

He turned and began ascending the hill at a ground-eating pace. "You're the only bona-fide doc we got left, so you can't get hypoxic now. 'Sides, it ain't fittin' for a gentleman to let a lady pass out."

I followed after them in dumb fasci-

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nation. There was something magnificent in Grimcat's insanity. His soul was a rare metal, minted by the Gods of DisEquilibrium.

Ninety minutes later, I was edging my way across the limestone cliff, roughly fifty meters from the cave-mouth, promising myself not to look down. My sweaty clothes stuck to me in the broiling sun, and I had a whopper of a CO_2 headache.

This part of the cliff was not that difficult a climb. We had a small ledge most of the way, and good handholds. The rock was dry, and my thick-soled boots clung admirably. Without a rope, with the mental confusion caused by creeping hypoxia, it was apt to become a different story.

Forgetting my promise, I glanced down at the city below, and the river cutting like a blue-green ribbon through the plantation and into the bay. If I glanced behind me at the plantation's edge, I'd see men slashing pods on Harmony flowers, their brown bodies glistening with sweat, machetes flashing in the sun.

Grimcat was ahead, Mbinga behind me. It worried me that I caught her yawning the last time I looked back. I don't think it was from tiredness; I think it was from hypoxia.

You see, it's not that there wasn't enough oxygen in the air, but that the CO_2 (about fifteen hundred times Earth ambient) pushed us to exhale faster than normal. That forces oxygen out of the blood, which is now more alkaline to make up for the increased acidity in the lungs. That leads to fatigue and mental confusion, which are amplified by the decreased circulation of old age. If the hypoxia becomes severe enough, you become nauseated and cyanotic, and your bone marrow starts working overtime to produce more red blood cells. This can lead to vasoconstriction of the lungs, and heart failure.

That's why, looking up at the cliff face, Grimcat was having second thoughts.

"Dammit, Leslie, that's just too much of a climb. You'd better stay here and let me come back for you in the shuttle."

You never saw such a fuss!

"You might prefer that I die lying down, with my back in the straw like a cow, but as a human being I reserve the right to decide my own Fate. I made a vow in the name of the Three Ladies, and if you don't like it, you can lump it. Besides, returning in the shuttle would take too much time, and increase our chances of being shot at."

Grimcat used lots of words I'd never heard before, but had to accede to her wishes. I didn't want her to fall off the cliff either, but there wasn't much I could do, aside from pointing out good foot- and hand-holds as we went along.

She was awfully spry (whatever her age) and despite the handicap of his wounded right arm, Grimcat moved along deftly. I'd begun to think we'd make it to the cave when I heard something that freeze-dried my blood.

The hunting scream of a quetzalcoatl.

"What'n the Nine Inhabited Worlds was that?" said the doctor before the final horrible note had died away.

"Welcome wagon," Grimcat chortled. "Gonna bring us supper."

I risked a glance upward. The plummeting bright speck confirmed my worst fears. "Quetzalcoatl—she's diving on us!"

I looked at Grimcat—he'd slowed down, moving sluggishly across a granite outcropping—and suddenly I remembered. Alaric had worn a red shirt. The xenobiologist said that quetzalcoatls near the city had learned to associate red with oxygenated blood, and that's why they'd attacked him and not me.

Grimcat's red hair would attract them like a beacon. Now eight meters from the cave, he had less than a minute to live.

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My foot slipped, and I snatched wildly at a handhold, dizzy and terrified of falling. He didn't care about me, to him I was just a tool. And a hindrance. He was everything I . . .

Admired. That was the terrible truth. "Grimmo!" I shouted. "She's targeting you!"

Slowly, the Elfour man unsheathed his knife and turned his back to the cliff wall, his moccasins braced against that pitifully narrow lip of rock. The futility of this was obvious—the impact would knock him off the ledge to the ground, hundreds of meters below.

"I got 'im!" Mbinga shouted, a pale, watery-green pulse spouting from the muzzle of her blaster. The beam hit the quetzalcoatl's right wing, but with no appreciable effect, then sputtered out. *Low on power.* The doctor tried again, and cried out in fury as her second and third shots fizzled harmlessly off the bony breastplate.

I was desperate to think of something. The quetzalcoatl was so close, the whistle of her huge wings sounded like an approaching whirlwind. The long, snaky neck was coiled in striking position, the wicked beak and curving claws ready to tear her prey limb from limb. It was just as it had been the first time, when I'd looked up to see that winged horror coming for Alaric.

Grimcat's knife made a silver streak through the air. It hit just below the creature's breast, close to the brain, but didn't go in deep enough. She was so hyped up on whatever they use for adrenaline, she probably didn't even feel it.

In a flash of inspiration, I snatched Dad's shirt from around my waist, balled it blue-side out and flung it at the creature as hard as I could.

She screeched like torn titanwood, and slammed into the cliff between me and Grimcat. I thought he scrambled into the cave-mouth, but couldn't be sure—the next few seconds were lost in an explosion of wings and fabric.

Flapping and squawking furiously, the quetzalcoatl regained its airborne status, scarlet and gold feathers and shredded pieces of shirt fluttering everywhere like pollen in springtime.

I dashed across the remaining ledge and flung myself into the cave. Sweet hard stone bruised my hands. Something landed on my back, terrifying me half to death until I realized it was Mbinga.

Grimcat was gasping for breath, his great chest heaving. He lobbed several fist-sized rocks at the quetzalcoatl as it hovered hopefully at the mouth of the cave; it shrieked in rage and then glided off with lopsided dignity, apparently giving us up as a bad job.

"Rafe, y'saved my life. What in muddy Hell for?"

"I dunno." I rolled over and sat up. His question embarrassed me to death, but I supposed I had nothing to lose by telling him. "Um . . . because I want to be like you."

That threw him. "How's that again?"

"You're your own man, and I'm just . . . Dad's little clone."

"Clone, shmone. I bet your Dad wouldn'ta thought o' throwin' that blue shirt. That was smart—same color as native animal blood. I owe you one, Rafe."

"Well . . . thanks." My mind was still trying to tell my overwrought nerves that the quetzalcoatl had gone. My heart was pounding in synch with my head, and seeing the doctor's frail body slumped on the floor only made me feel worse. "Dr. Mbinga!"

Her eyelids fluttered. "I missed. Haven't missed a shot in . . . thirty-seven years."

"You didn't miss, you were out of juice," I said as Grimcat and I helped her up. "C'mon, there'll be oxygen in the shuttle."

Going up to their ship. I wasn't going anywhere.

"Can't hit a bird half the size of a barn, might as well hang it up." She coughed and retched. "Gettin' old, but if I wanna hang the wall straight . . . I

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mean . . . I was just saying something important, but it wasn't about the dang wall. . . ."

"Yeah, no more gallivantin' around for you," Grimcat said, picking up her backpack and dusting it off. "But don't worry, my granny says she can always use more help with her quilting . . ."

I just hoped we could get an O_2 mask on the doctor before she lost too many brain cells. She was deep in hypoxia, probably already turning blue. Not that I had that figured out, as dark as she was. I was no doctor, just a hypochondriac.

"*Quilting*?" Mbinga repeated, her eyes goggling.

Grimcat wore a big, concerned smile. "Yeah, Leslie, you'd be great at it. Now how 'bout I carry you to the shuttle? Upsy daisy. . . ."

"The Hell you will!" she snapped. "Once is plenty, thanks! Gimme my backpack! Let's get a move on, Boss Man—we ain't got all day!"

"I'll take it," I said. "Hey, it's not like you're old or anything, but I haven't carried anything the whole time. It's my turn."

"Well . . . all right."

"Thanks, Rafe." Smiling, Grimcat handed me her backpack, then took a flashlight out of his carry sack and switched it on. "Ready?"

Still glowing from his thanks, I slung the pack over my shoulders. It didn't weigh much. This was as far as Alaric and I got when that thing killed him, and it gave me a tremor to realize that his blood must still be in the cracked stone beneath my boots. "Are you sure you know the way to the other opening?"

"Yeah. There's a fork in the tunnel . . . we take the left one."

"OK." Matching stride with the doctor, who seemed to be muttering under her breath, I followed Grimcat and the harsh white beam of his flashlight. Dust particles danced in the beam, and the noisy sound of our exhalations nearly drowned out the clomping of boots on stone.

It was blessedly cool compared to the oppressive heat outside, but I must confess that I did not care for such enclosed spaces as we now found ourselves in—the tunnel narrowed quickly, so that we had to walk single file, Grimcat's head nearly scraping the ceiling. I was yawning so hard my eyes watered, and my mind wandered off into all kinds of crazy daydreams.

In the middle of one of them—I'd just chopped off a quetzalcoatl head with a machete, and a second, fire-breathing one grew in its place—I realized we'd stopped moving. Peering into the gloom, I saw that we'd come to the fork. "Why're we stopping?" Grimcat rubbed his forehead. "I think it was the left . . . but maybe it was the right. Muddy Hell, I disremember!"

"We're goin' northwest," Mbinga said, aggressively holding out her wrist with the glowing minicomputer. "Right? Harrison says the left one's better."

"That don't mean nothin'. The trail switches back and forth all the time."

She started to cough, great nasty racking coughs that made me ache to hear them. "O' course we switch back and forth! But we're so close now . . . how far off can we be?"

So we took the left fork. Grimcat didn't have any better ideas, and as for me, my head hurt so bad I could hardly see straight.

After some interminable time, Grimcat stopped. I discovered this by bumping into him. "What's wrong?"

"Muddy Hell!" Grimcat said, which was no explanation at all. I peered around him.

The tunnel had opened up suddenly. A great semi-circle stretched out before us—as if half the top of the hill had been hollowed out.

Stone slabs fanned away from us at regular intervals, like many Guardia standing at attention, and straight ahead of us lay another piece of stone, only this one was on its side.

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"This ain't the right way," the Elfour man muttered.

"Then we'll just go back and take the other one," I said. The weariness in his voice alarmed me. I prayed he wouldn't faint, because I knew I didn't have the strength to carry him.

"Looks like . . . temple," Dr. Mbinga said, and fainted.

I caught her before she hit the ground. It was easy; she fell on me. "I've got her," I said anxiously. "C'mon, Grimmo, you lead and I'll follow."

"We're goin'," Grimcat said, but he had to stop and retch. His flashlight beam fanned the floor, and I saw something glint. At first I thought it was water, or a shiny rock. I poked at it with the toe of my boot, and it caught the light so, I bent to pick it up, all the while hanging onto Dr. Mbinga.

Maybe it was just a pretty rock, but it sure looked like there was metal in there somewhere. A little smaller than my palm, it was mostly round, and no more than a centimeter thick. The light wasn't good enough to make out anything else.

I stuffed it in my pants pocket and picked up Dr. Mbinga. Her head lolled against my shoulder, and I was acutely conscious of her stentorian breath rasping in my ear.

"Let's go afore I puke up the entire contents of my stomach," Grimcat said, staggering out into the passageway.

Five minutes later, we were out in the sunshine and running down the hill toward the launching pad. The right-hand fork had led directly to the exit, and the boards had been dead rotten—one good kick took care of them.

I could see the shuttle down there waiting for them, its shiny metal carapace bright as a promise. No armed men; nobody shot at us. It could still happen, but it seemed less and less likely. Either General Pennick had stationed them on the road down below, or he was too intimidated by Colonel Daggs to try anything stupid.

The wind blew my hair, and I breathed it in in great gusts. Better than the mustiness inside the cave, but every cell in my body was screaming for more oxygen. Worse than suffocation was the thought of Grimcat and Dr. Mbinga leaving me here to make myself useful to General Pennick.

"Grimmo . . . take me with you," I gasped. "I'll work hard, I swear! Don't care . . . how much. Just don't . . . leave me here. Please!"

His bloodshot eyes rolled at me. "We're going back to . . . a high-gravity planet . . . where workin' to earn your keep . . . makes your slave labor look easy. We got sickness . . . you ain't been exposed to it. Your friends . . . still prisoners."

"I'm not afraid of . . . those things," I said. "Well, I am . . . but not like I used to be. And UEMCo's got to get along with my people . . . if for no other reason than . . . they'll go broke if they don't. I'll come back to free them someday . . . but I can't learn what I need here. Only you . . . you can teach me. You *have*. And you owe me one, remember?"

Arriving at the shuttle a few seconds before I did, Grimcat threw back the door and opened the big box on the front seat. It was full of gray cakes of processed gum. "Might be worth it . . . see Pennick turn six shades of purple. But I won' cut you no slack, and neither will Daggs. You work like a government mule . . . like the rest o' us slobs. You got to accept that . . . part of the bargain. More often . . . you'll prob'ly hate our guts."

The joy I felt nearly split me in two. "You watch me, Grimmo! I *want* disharmony to teach me about me. I'm going to be iron on an anvil, throwing sparks with every blow."

I set Dr. Mbinga in the front passenger's seat and hooked her up to an oxygen tank.

She's going to be fine. I could tell just by the way her eyes smiled at me.

Maybe I don't make such a bad Buck Rogers after all.■

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THE ALTERNATE VIEW Jeffery D. Kooistra

CALLING DR. DIOGENES

I hope this month's ramble doesn't offend too many of the doctors (and in this column, "doctor" will refer to medical doctor) in the audience. I mean, if the shoe doesn't fit, don't wear it, and doctors who read *Analog* are a pretty select lot to begin with.

I have not been slow to pick on physicists who fail to examine experimental data, nor on scientists in general. Some may think this month's column sticks it to medical doctors in much the same way. Such is not my intent. I work at a hospital, I see some of what doctors go through every day, and unlike ordinary scientists, doctors work under the ever-present "threat" of a malpractice suit if they make a mistake. (And then there're those HMO guidelines about how to treat their patients, insurance company shortsighted policies . . .)

But this is a matter of life and death.

Sooner or later, everyone dies, but when accidental death results because of negligence (I'm thinking of babies left in locked cars on hot days at the moment) we find this particularly repugnant, consider it criminal, and it makes us feel both frustrated and angry. Sometimes illness takes us early. We go to doctors hoping they can cure us. Oftentimes they can; sometimes they can't.

Sometimes they won't.

This last is the problem my friend is having.

It isn't the result of deliberate malfeasance. Sometimes it's probably part fear of "the lawsuit thing"; other times partly an "insurance thing." But almost all times it seems to be an "ignorance thing."

My friend has a chronic infection that is killing him. He is suffering from an undiagnosed meningeal infection. The reason the infection remains undiagnosed (by the medical profession, that is) is because he cannot find a doctor who will do the necessary biopsy and take a culture from the dural/periosteal interface in the left temporo-parietal region of his skull. (For those of you not up on your medical terminology, the dura, or dura mater, is the outermost part of the sheath that covers the brain, and the periosteum is that layer of cells overlying the bones. The temporoparietal region is the side of your head, around your temples and ears.)

At this point, you readers are wondering 1) why won't the doctors do the biopsy? and 2) how the hell does he know he's got this infection?

It started with a cat bite, deep and bone-penetrating. The infection that followed the cat bite developed into infectious arthritis, which was—*eventually*, after delays—diagnosed. That condition was of joint-locking intensity and lasted for over seven months. It's been all downhill from there, due, according to my friend, to the infection moving into his bones and up his vertebrae, and an interesting yet deadly medical catch-22. You see, to reliably diagnose a bone infection, one needs to have a biopsy taken, and this is an invasive procedure. So as a precursor to this, one must have a non-invasive procedure performed first—X-rays and MRIs and CT scans typically, to see if the invasive procedure is warranted.

Ah, but the noninvasive procedures

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are not always reliable for finding indications of a bone infection. On my lap as I write is an article entitled "Failure of Computed Tomographic Scanning to Demonstrate Subdural Empyema," by Dunker and Khakoo (*JAMA*, September 4, 1981–Vol. 246, No. 10). The very first sentence reads: "We report two instances of patients with typical pictures of fulminating subdural infections in whom the computed tomographic (CT) scans were misleading." The fourth sentence: "These cases characterize the hazard of relying on a nondiagnostic CT scan in a septic patient with deteriorating function."

That answers question 1. The doctors won't perform the biopsy because the radiological data either doesn't show the infection (and besides, it's in his *head*) or because those indications that do appear can be written off as something else.

As for question number 2, the reason my friend knows he has an infection is because he can feel it inside his head, and he's a very, *very* bright man (four degrees) who knows how to keep track of his own symptoms and how to research medical literature. He also knows how to self-medicate with antibiotics, or he'd be dead already. (Even with the antibiotics, he has his good days and his *very* bad days.)

Yes, doctors, I know—a person self-medicating is frowned upon. But what would you guys do if you knew you were sick and could die, and you couldn't get in to see a doctor for three weeks, hmmm? He'd had some antibiotics on hand right at the beginning of his problems, and they seemed to help. But the "downside" of surviving was that, the antibiotics having worked well to reduce the infection, my friend looked rather healthy by the time he finally got to his appointment, and that doctor didn't take him seriously. After that my friend began procuring antibiotics clandestinely.

At this point in the account, I guess I should admit that I have not, as I write this, met this friend of mine in person. He's an Internet buddy. Some of you are probably immediately suspicious of this story now. I understand the feeling. But I am not suspicious, and since in my last column I brought up the topic of believing what we want to believe, let me go into why I trust this fellow's account.

For one thing, we "met" because of comments he faxed over concerning this little motor gizmo I've been working on lately (another column for you to await for details on that). It was only in passing that he mentioned some medical difficulties. I asked about those and thus heard the whole story. And yes, he knows some might think he must be a hypochondriac (we'll discuss why that isn't so in a bit). But most of our e-mail interactions have dealt entirely with physics. He told me he's a physicist, and, well, you just plain can't *fake* knowing physics. In our discussions, he's sent me *tons* of references to interesting papers, and they're genuine (not to mention certain patents, websites, etc. that he's also led me to). So I'm confident that he's telling me the truth about his being a physicist—he's shown me the goods on that.

Another reason I trust his story is because I was already primed for it from reading about another physicist's difficulties with doctors, he being Richard Feynman, and the account being related in his *What Do* You *Care What Other People Think?* Feynman's fiancée Arlene had developed a lump on her neck, then later got a fever that left her bedridden. In the hospital, she was told she had typhoid fever and placed in quarantine (special gowns, masks, the whole nine yards). Right away Feynman went to the books, read up on typhoid fever, then asked the doctor how the Wydell test came out (In the Wydell test, you look for bacteria in the feces—an absolute test for typhoid fever). The doctor told him it was negative. So they had Arlene quarantined and they couldn't even find

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the bacterium in a stool specimen. But rather than reconsidering the diagnosis, the doctor spoke to Arlene's parents, who told him not to interfere.

Later, Arlene seemed to get better, then worse again, and off she went to a different doctor who felt her here and there and decided she had a problem in her lymphatic glands but he didn't know what. So Feynman went to the library and found listed first under Swelling of the Lymphatic Glands—Tuberculosis of the Lymphatic glands. The book said this was very easy to diagnose. So Feynman decided that couldn't be it since the doctors, who were having trouble finding out what was wrong with her, surely would have been able to diagnose something that was easy.

The rest of the account is heartbreaking, with Arlene being misdiagnosed as having Hodgkin's disease, Feynman being force to lie to her about having something else, and ultimately, Arlene dying five years later of, of course, Tuberculosis of the Lymphatic glands.

The last reason I'm going to tell you for why I trust my friend is because of the references to items in the medical literature that he sent me (like the *JAMA* article quoted above), along with very specific comments detailing just where in these articles the relevant material is and why he thinks it's important to his case. (This is exactly the sort of thing I would do, by the way. Unfortunately, unless someone knows you, this also tends to make you look like a hypochondriac—obviously, you have this obsessive interest in medical literature. . . .) Since I work at a hospital I was able to find the journal articles referenced in only a few minutes, and they are most definitely relevant to the symptoms he describes.

I'll mention another article in particular, it being "Spinal Epidural Abscess," by Ann S. Baker *et al*, in the *New England Journal of Medicine*, vol. 293, #10, pp. 463-468. This article deals with 39 patients with spinal abscess and how they were evaluated at Massachusetts General Hospital between 1947 and 1974. Right off you can note that 39 patients in 27 years ain't too many, so aspects of my friend's condition have not been of the everyday variety. The description of symptoms is frightening, paraplegia being common. Of greatest note for my friend is the mention of four patients in this study (about 1 in 10) who had described "electric pain," which was written off as being hysterical, not genuine. Left untreated, those patients died. My friend has suffered from the electric pain.

Could my friend really be a hypochondriac? Well, can a hypochondriac make bubbly pus appear behind his ears? The doctors have seen this otoscopically. Can he fake a rheumatoid factor of 172? A medical lab has measured this.

My friend is running out of ideas for what he can do. He's copied all the articles himself, and brought these to various doctors to read, which they subsequently fail to do.

Like I said, my friend is no dummy. He worked on NMR (quantum crystal magnetics) theory for several years prior to this episode. Before that, he did particle beam work in SDI. His senior projects included analysis of CAT biophysics and data processing algorithms. He tutored in pathophysiology and pharmacology. He understands very well how radiological examinations can fail to find his infection, and like I said, he's also tracked down the medical literature that spells all this out.

Prior to meeting me, he exhausted most of his other options. He tried to reach Dr. Ann Baker, but she'd gone on sick leave and was unreachable. Her coauthors have also been unreachable and she died a couple of years ago. He's tried to reach the authors of other articles he's referred me to. Usually they can't be found, but in one case, she told him he "should trust" his doctors even after he'd explained to her how they were ignoring the goo coming out of his ears,

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as well as the positron-emission spike on the white cell scan (one instance where radiology *did* find something—the machine operator saw it, but the radiologist ignored it).

So we're looking for an honest doctor, one who can be honest enough with himself to realize that now and then a patient might come along who is intelligent enough to diagnose his own medical problem, even if that problem is one the doctor might not be familiar with, and even if previous tests following accepted protocol have failed to find the problem.

Article lead-time is a difficulty, but hopefully, my friend will still be alive by the time you readers see this. Internet-savvy doctors willing to find out more about my friend's problem can access <http://www-vms.oit.umass.edu/~alah000/plea.txt>. Others who want to help can contact me care of *Analog*.

Is there a Diogenes in the house?■

IN TIMES TO COME

Our lead novella for January is "Finding a Voice," by relative newcomer Shane Tourtellotte. A central topic in science fiction has often been the problem of communicating with nonhumans. Some stories take a solution for granted and gloss over the difficulties to get on with something else; in others, communication itself is the main focus of the story. But there's one aspect of it that doesn't come up too often. What if you *have* to communicate with aliens, but the nature of their language is such that very few humans can deal with it and the only one available is severely lacking in communication skills with his *own* species? That's the problem Tourtellotte's stranded spacefarers face: they *have* to deal with the locals, but the only one of their number who can talk to them is one they can't stand but on whom they're completely dependent.

We'll also have stories by such writers as Jerry Oltion and Allen Steele, and a fact article on "Cardiovascular Medicine: The Current State of the Heart," by the eminently qualified H. G. Stratmann, M.D. In essence, cardiovascular medicine is just plumbing but very delicate, sophisticated plumbing!

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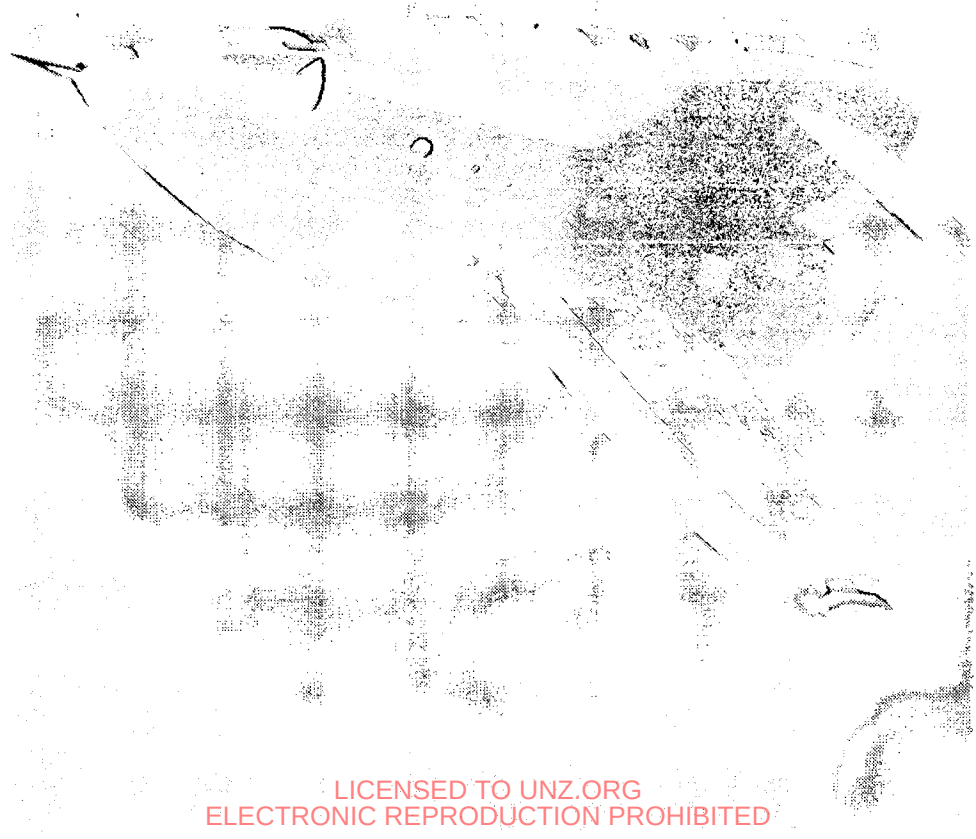

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"It looks so close. It's almost as if I could reach out and touch it," Helen remarked breathlessly as she pressed her forehead to the elevator's thick transparent pane that separated her from the thin and poisonous atmosphere of Jupiter. Far below she could see an upper level torroidal disturbance move slowly from right to left as they followed mighty Jupiter's rotation. She could even make out the wisps of the storm's arms to either side.

Her pilot snorted as he glanced over her shoulder. "Take an awfully long arm to do that. Top of Jupe's clouds are still thousands of klicks below us."

Helen pulled back. It took an act of will to wrench her eyes from the awesome sight. "So far?" Suddenly the fragility of the shell around her and the pitifully thin cable on which their elevator travelled became all too obvious. If the threads from the synchronous station that extended into the atmosphere were to snap they would be pulled down into Jupiter's massive gravity well. She shivered at the prospect. Why had she fought so hard to come here to this far-flung outpost of humanity?

Jack, her pilot, smiled. She wondered if he'd seen her momentary start of fear. "Don't you worry, honey. Safe as can be here. Shoot, even if the cable broke we'd survive for maybe a day or so."

"Enough time to rescue us?" she responded, imagining the elevator floating along in Jupiter's upper atmosphere.

"Naw," Jack grinned with his crooked smile. "It'd take us that long to fall down to where the pressure would collapse the shell." He squeezed a fist to illustrate his horrid point.

Helen was aghast. How her pilot could find humor in the possibility of such a dreadful death was beyond her. "That's . . . It's . . ." She stopped when she saw him grin. Obviously it was a joke he'd pulled before. "Never mind," she said as she forced herself to smile. "How long before we reach the station?"

Jack glanced at the odometer mounted on the elevator's wall. "I'd estimate we've got another couple hours before we arrive at the lower station. That is, if the brakes manage to stop the elevator." He looked serious for a moment before breaking into another of his lopsided grins. The pilot had been in good humor since they left synchronous orbit. "Always look forward to a chance to fly," he'd remarked without prompting when they had been introduced.

Helen thought that Jack was as crazy as Frederick, her brother. She couldn't understand how they could like flying a sailplane on the biggest planet in the solar system. Soaring in Jupiter's atmosphere had to be at least a hundred times more risky than flying through a hurricane. No, make that a thousand, a hundred thousand times more risky!

Helen turned back to the porthole and watched the monstrous weather on fierce Jupiter roil beneath them. Was she any better, to have come all this way?

When Helen Sandallson had taken her graduate studies in meteorology she hadn't intended on becoming a member of the government's interplanetary science team. Instead she'd concentrated on becoming an expert in the massive storms that were taking an increasing toll on the coastal states. Hurricanes had always fascinated her. As a grad student she'd flown with the hurricane hunters, ridden the weather fronts across the Midwest with some crazy storm-jumpers, and roared up and down country roads chasing tornadoes in a beat-up Land Cruiser full of other weather freaks.

By the time she received her doctorate she knew more about the internal structure of hurricanes than anyone else. She knew the isobaric, stratigraphic, and thermoclinic structures of these monsters more intimately than her contemporaries knew the bodies of their lovers.

To her the monster storms weren't simply signs of nature's torment. To her, every hurricane had a unique personali-

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ty. Each one was built by the same elements of formation but varied widely. Each storm was shaped by the way it interacted with the weather patterns surrounding it. She knew every type of hurricane; from the thundering monsters who marched with unstoppable, direct force across man's puny constructs to the capricious ones whose moves could not be predicted with any certainty.

When they put her doctorate's cowl over her head she looked forward to a life of study on Earth, a life devoted to study of Earth's strongest weather events. She never expected to come to Jupiter.

"Here's the station," Jack said suddenly, and Helen jerked herself awake. He was pointing out the port. She followed his finger and saw a gray plain. It grew to fill more and more of the port, blocking the view of Jupiter's darkening face. Since they had left synchronous orbit they had gone through one night cycle of the giant planet and were starting on the second.

The elevator clanged to a stop. "Everybody out," Jack said with a smile. "Watch your step—Jupiter's a long way down." He grinned again and Helen shuddered as she took a cautious step through the lock and onto the deck of the station.

Her brother had started it all. While she was storm-jumping in Oklahoma, Frederick had become enthusiastic about sailplanes. His interest had overshadowed everything, and he dropped out of school to train for international competitions. While she was working her way to her masters he had been gaining a reputation as a daring and skilled pilot. Around the time she was starting her dissertation he'd taken a job with Blacker Corp, the multinational who was managing the UN's Jupiter project.

"Think of it, sis," he'd said when she tried to talk him out of it. "Flying in the upper atmosphere of the biggest planet God ever created! What a rip that will be. I heard that you could stay aloft for weeks, months—hell, you could fly forever in those winds."

"But what about the danger?" she'd protested. "Jupiter isn't Earth—the atmosphere's pure poison, the pressure would kill you, and there's no place to land safely. If you can't make it back to the launch point you'll die. We don't know that much about the wind patterns—the laminar flows would be quite disruptive to flight, for one thing. No, Fred, it's a stupid idea. It's too risky. Why would you think of doing this—are you in love with danger? Is the money worth your life?"

Fred laughed. "You think flying in competition is safe? Hell, sis; that's getting boring and, to answer your question: yes, the money is damn good—more than I'd ever make from flying on one of the competition teams.

"But at least I get some enjoyment out of it," he went on. "What about you, working so hard on that meteorology stuff. I know it can't be the money that attracts you and I can't see you having any fun."

Helen had seethed with anger. How dare he criticize her work? "It's not about having *fun*, as you put it. It's about making nature reveal something we don't know. There's a real thrill in discovery, Fred. There's a high in revealing something we didn't know before. Maybe it looks boring to you, but science is pretty exciting for me."

"Well, maybe flying is that way for me, sis. I love flying; the sky, the winds, the clouds and even the storms. Sure, I worry about what Jupe could do, but I'm not going to let that stop me."

In the end she hadn't been able to talk him out of it and so he'd gone to Jupiter. He was too caught up with the wonder of that magnificent planet to fear it. She knew in her heart that he was going to die some horrible death. Stupid, stupid, stupid!

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Fred's messages kept her informed about developments on Jupiter. Already they'd put teams on several of the moons, established Jupiter's synchronous satellites, pushed two elevator cables down into the atmosphere and were working on a third. Fred flew one of those fragile sailplanes from one of these.

Blacker funded their operations by supplying scientific information to any organization that had the funds. Most governments felt it was cheaper to pay Blacker Corp than launch their own investigations. For those who wanted to send their own people, Blacker was quite willing to provide transport, room, board, and tools—all at a marked-up cost, of course.

Then one message had told her something so startling that she still had a hard time believing it. Some of the deep probes had discovered a sharp discontinuity in Jupiter's deep atmosphere. Below the discontinuity, the atmosphere was ten or more times more dense than the air above it!

The implications of this were not lost on her. She immediately proposed that this layer acted much as Earth's oceans did in the formation of Jupiter's mighty storms. This viscous layer, she theorized, must transfer the heat from Jupiter's inner fires to its thinner atmosphere.

Her paper was met with some derision, some opposition, a little praise, and a whopping big grant from the World Weather Watch to join their atmospheric study team on Jupiter.

It was the opportunity of a lifetime, something that would establish her reputation. No matter what she discovered it would be something new, something no one had seen or found before. It was the cutting edge of science and she could be a part.

But why did it have to be Jupiter?

The final decision to accept wasn't easy. Helen bought a huge insurance policy, sold all her belongings, and spent all of her remaining funds on a week-long blowout in Acapulco. She showed up for the launch completely drained and satiated. Now she could die in peace.

"Ready to go?" Jack asked as he strolled into the station's tiny galley. Helen was sitting at one of the fold-down tables, sipping a warm cup of tea to calm her nerves and nervously glancing through the nearest window. The tea helped settle her stomach from the massive doses of anti-radiation medicine they had to take. The incessant howling of the wind outside wasn't helping her nerves or her stomach. Occasionally a particularly strong gust would rock the station, momentarily disorienting her as the floor shifted slightly. The winds at this altitude were mere breezes compared to the might of the storms further down. Still, they were far stronger than anything the most aggressive of Earth's hurricanes could achieve. She kept asking herself what was she doing here.

Jack was dressed in his flight suit, a tight-fitting pressure garment that had more adjustable ties and snaps than anything she had ever seen before. He carried his helmet under one arm so that the oxygen tubes dangled beneath it like the entrails of some beheaded beast. The suit was designed to keep his blood from pooling as he sat for hours in one position under the heavy pull of Jupiter's gravity in the sailplane's cockpit.

Her own gear was a lot less complicated and more flexible. While Jack would have to sit up front without moving for hours and hours, she would be moving around in the science compartment—a relatively spacious two-meter-cubed bay—to perform her experiments.

They weren't going to accomplish much on today's trip. This first venture out was just to get her used to the environment where she'd be working for the next year. Just the same, she knew it was going to be quite different from the sim-

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ulations she had trained on during the long trip out from Earth. For one thing, the simulators hadn't scared her to death.

Jack explained what would happen as they went through their pre-flight checkout. "We'll be launching off the back of the station. First thing you'll feel is when they drop us and we fall below the station. Takes a second or so before we lose protection from the wind."

Helen pictured the situation in her head. The sailplanes were held nose-fast to the downwind side of the station. They looked like a group of remoras sticking to the mother shark of the station. Launching the plane consisted of dropping nose first toward Jupiter to enter the slipstream of the several-hundred-meter-per-second winds that howled around the station.

"The nose is going to jerk up soon's we bite the wind," Jack continued, explaining how the plane would suddenly achieve lift from the wind flowing over her stubby wings. Long narrow wings like the sailplanes of Earth would be ripped apart in the torrents of air that flowed in Jupiter's upper atmosphere.

Jack continued with his description of the profile. "I'll be pulling her to the left when that happens so we don't ram into the station. Don't worry about that. It's standard protocol." Helen wondered how many lives had been lost learning that little departure trick and what the margin of error would be when they did so this time.

"Once we're clear of the station, things will calm down a bit," he went on. "Then it's just a matter of finding the right pressure ridges and maintaining altitude." Helen wondered at how casually Jack could speak of the invisible mountains of air that the plane would use to keep itself suspended.

"We're going to go about a thousand klicks north and then run straight south before we bend back to the station. Didn't you say you wanted to make your drops somewhere along the second leg?"

"Right, I want to check out the new telemetry on these probes. We're still not too certain of how deep we can go before the spread spectrum radio becomes ineffective. I can't believe the noise levels out here."

Jack whistled. "Ready for the drop. Yeah, I know what you mean. We couldn't talk to the stations without the good old double ess rigs. Still pretty useless for our longer trips when we get out of range. Jupe's a pretty noisy bastard in the radio frequencies. Watch your head! Here we go!"

Helen clutched the handles on the instrument rack and held tight as the deck dropped from beneath her. For an instant the heavy drag of Jupiter's gravity disappeared and was replaced by her stomach's instinctive clench of fear of falling.

Then the deck slammed up, driving her hard against the unpadded seat and making her suddenly regret the tea she had been drinking moments before. No sooner had that happened than she was thrown to the right. She lost her grip on the handles, but the safety belts held her in place.

"Did you remember to hold your head against the rest?" Jack asked over the intercom.

Helen cursed under her breath. From the ache that was beginning in the back of her neck she knew she was going to have a monster headache. He was right, damn it; he had warned her.

"Look out on your right," Jack said. "Ain't that a pretty sight?"

Helen looked through the tiny porthole on that side. Far away—it was hard to judge distances without a reference point—was a short gray cylinder at the end of a thin rod that extended beyond the upper edge of the tiny round window. For a moment she didn't understand what she was seeing, and then perspective snapped into place: It was the station they had just left!

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"We're about twenty kilometers away," Jack told her. "I thought you might like a look before we started our run." The station slid out of sight as Jack banked the plane to head northward.

Helen was fascinated by the scenery that surrounded them. Everything outside was shades of orange and tan, of brown and ivory. It was an Arizona color scheme; a New Mexico sunset of a skyscape; a desert of russet colors. Far below she could see the cyclonic shapes of the storms formed by the lateral wind bands. Between the storms she could pick out the puffy cumulus-like eruptions where some heat engine was blowing through the lower layers. By leaning forward and looking up she could see the gray wisps of some upper-level cloud and, beyond them, a deep purple sky spotted by a few bright specks. Whether these were stars or some of Jupiter's moons she had no idea.

She drew back with a sudden feeling of panic as the immensity of what she was seeing overwhelmed her. Those innocent clouds belied their menace. Those storms were larger than any of Earth's continents, some were larger than Earth itself! It was only the vast distances that made them seem so insignificant. More frightening was the thought that there was nothing beneath her feet but kilometers of empty air—*thousands of kilometers!* Were anything to happen to the plane they would fall forever, just as Jack had joked.

The scene outside suddenly appeared alien, foreign, beyond her experience. Those hurricanes would never acquire the familiar green cast from thousands of tonnes of water. Clear, clean rains would never fall from them. Beneath that cloudy surface was the real Jupiter. Beneath the cloud cover was a hell of temperatures approaching that of a failed sun. Somewhere near the bottom the pressures were so intense that even hydrogen was compressed into a metallic substance.

Would she ever get used to the sight, she wondered as Jupiter drew her eyes back to his breathtaking vistas. It was at once the most beautiful thing she had ever seen.

And the most terrifying.

The arc of darkness swept toward them with amazing speed. Jupiter rotated on a nine-hour cycle and pulled its atmosphere along with it, but slightly behind. At this altitude the atmospheric drag meant that they would have about a nine-and-a-half-hour cycle, which made not a bit of difference in her work.

"We'll make the first turn soon," Jack announced over the intercom. "You all right back there?"

"Everything's fine," Helen replied. "I've just been calibrating the instruments for the drop."

Jack chuckled softly. "My first trip out I didn't want to do anything but look. Couldn't take my eyes off of those clouds, those storm eyes, and the colors. Most beautiful damn thing I ever saw—and still is, for that matter."

"Don't you worry about something happening?" she wondered. "I mean, this must be really dangerous for you." And me, she added silently to herself.

"Danger? Never think of that. Once I get the plane under me all I can think of is how great it is to fly these winds. If I didn't have to eat and sleep I could float on these winds forever, like one of those albatrosses back home."

Helen shuddered again, thinking of what the albatross meant to those who sailed the sea. "You mean sea gulls, don't you?"

Jack laughed. "Whatever, but like a bird, you know."

The drop went flawlessly. Telemetry from the packages came in as their plane circled the drop zone. Helen constantly fiddled with the instruments as the noise deteriorated the signal until finally the last whisper of clean data

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ceased. "That's it," she said. "Let's go home."

"Turning," Jack said in response and tilted the plane sharply to the right and down. Helen panicked as she felt the plane drop away beneath her. Something had gone seriously wrong and they were falling into Jupiter's warm arms. She could hear the wind howling along the side of the plunging craft, feel the shudder of the wings as they cut through the atmosphere. She was going to die! "What's happening?" she screamed, but there was no answer from the pilot.

Then the nose snapped up and they leveled off, leaning to the left this time. Helen was thrown back into her seat. She felt the growing pressure on her buttocks as if she were in a gently rising elevator. "What's happening?" she said more quietly, when she quelled her panic and remembered to press the intercom button. She was glad Jack hadn't heard her scream.

"Found us a nice thermal," Jack answered. "We lost about ten kilometers of altitude while we were circling and I had to find a rising column to get us back to the station's altitude."

"Ten kilometers!" she yelled. "I had no idea we were dropping that much! Why didn't you tell me? Why didn't you warn me that we were losing so much altitude?"

"Nothing to worry about. Shoot, I dropped nearly a hundred klicks in one downdraft a while back. That's one good thing about flying on Jupiter; you don't have to worry about bottoming out on the deck." He laughed again as if they had been on some sort of amusement park ride.

Helen was not amused in the slightest.

As the weeks and months passed, her flights into the atmosphere grew more and more routine. Helen no longer clutched the sides of her seat when the plane veered, nor did her stomach clench in fear when Jack dropped the plane a few kilometers to gain air speed. She had gotten quite used to that sort of aerobatic maneuver.

She immersed herself in discovery. Her theoretical model of the atmospheric phenomenon continued to hold true as the data rolled in. She also learned that dropping the probes away from the storm centers provided better telemetry returns. "Further from the lightning," was Jack's explanation, which was as good as any.

She was getting better results than the team over on Beta station, a third of the way around the planet. In a month the two of them would switch and she'd be on the same station as Fred. It'd be good to be working together.

What they were discovering about the P3 layer was fascinating. Jupiter's completely unexpected atmospheric stratification was being studied with every resource they could throw at it. Her own piece of the study was to determine and map the wind shear effects between the viscous bottom layer and the winds above. Already she knew more about laminar displacement than anyone else. This research was a gold mine of opportunity!

As she sent yet another probe from the plane she wondered what all of her data would really do for the bulk of humanity—was it really worth the time and effort, the terrible expenditure of resources? As far as she could see there would be no direct benefit to be gained from the work, aside from scientific knowledge. So far as she could tell there were no significant differences between the barrier layer here and the water/atmosphere interface on Earth.

"I hear they're dropping a big probe down to Beta station," Jack reported during their next preflight briefing.

"It's a buoyant probe," Helen remarked. "The team's going to drop it directly from the station. We hope that it'll float on the barrier layer and maybe give us continuous data returns. We should

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get better results from that than we do from these short-term probes."

Jack growled. "Which means fewer flights, don't it?" He sounded as if he were a little bit angry.

Helen puzzled over the source of his displeasure for a moment before she realized that he was concerned about an early end to his flying. They were barely halfway through the contracted eighteen month assignment of her grant. "We'll just be doing something different, is all," she said reassuringly. "Lots of other reasons for you to get out here."

"Hope so," Jack mumbled. He still sounded suspicious.

Word of the disaster came down the cable early in the morning. Helen was still drowsy from the few hours of sleep she'd gotten since she'd returned from their last flight. She stumbled to the doorway and flipped the latch to see who the hell was pounding on it. Didn't they see her *Do Not Disturb* sign?

Jack was standing outside with a strange expression on his face. He'd thrown a jacket over his issue sleepwear. "What's so damn important that it couldn't wait until I've had my beauty rest?" she said sarcastically. "This better be good!"

Jack grimaced as if something were eating his entrails. "I told them I'd let you know," he began in a halting voice. "There's been an accident over at Beta."

"Fred!" she screamed at once. "What's happened to my brother?" Visions of a hundred things ran through her mind. Was it a suit failure that let in some of Jupiter's poisonous atmosphere? No, he'd fallen and broken something, just like when he was a kid, or maybe his plane was overdue—Fred was never a stickler for punctuality. Or maybe—she swallowed hard—maybe something had happened to his plane. The thoughts of him plunging deeper and deeper toward Jupiter's hellish depths froze her to immobility. No, it couldn't be.

"It wasn't just Fred," Jack went on quickly. "That probe thing broke loose on the way down and tore the station off the cable. We lost everybody—the whole damned station!" He reached out to Helen and began to cry. "Beta's gone!" he wailed.

Helen couldn't believe it. Everybody? An entire station? Sixty souls? It was beyond belief. The stations were the only points of stability on Jupiter, anchored firmly to the cables that extended clear to heaven and beyond. How could this happen? How could they allow something like this to happen to her Fred?

But she didn't feel any emotion whatsoever. She held Jack close and patted his back while making soft "There, there," sounds. It was too much to grasp, this sudden loss of life. Shouldn't she feel something—sadness, anger, or fear? But no, all she felt inside was an ice-cold knot as she tried to imagine what it must have been like for those inside the station as it fell for hours and hours until it impacted her P3 layer.

She calmly did a few quick calculations in her head and realized that the displacement of the station would not be enough to allow it to float on P3. No, the station would have torn through the P3 and continued to fall to certain death far, far below. "Fred," she said simply as Jack continued to sob uncontrollably.

No work got done the rest of the day. Synchronous orbit said that they were sending the elevator down for anyone who wanted to leave, but it wouldn't arrive until late the next day. Helen put her name on the list with many others. There wasn't any point in continuing her work with three quarters of her study team dead. She wondered whether the work would stop or be revitalized at some later time—some later time when she was safely back on Earth riding some nice, safe hurricane tracker.

The crew held a brief memorial ceremony for those who had gone down with Beta. Helen was the only one with a relative aboard and so got to sit in the

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tiny galley, surrounded by the many who had friends, companions, colleagues, and casual acquaintances on board the ill-fated station. During the eulogies she was surprised to learn that Jack knew all four of Beta's pilots and most of the station staff. He'd flown many missions from Beta in the past.

They sang "Almighty Father" off-key at the end of the service. Helen choked when they got to "and those in peril in the air" and couldn't read the words for the tears in her eyes. Deep inside, her loss of Fred was starting to change from a foggy intellectual awareness to an emotional storm. Although she was still pretty numb, she knew that, in time, she would grieve. She knew that one day Fred's death would overwhelm her in a tidal wave of sorrow. But not now, not here in front of all these other sad souls. She knew that she wouldn't be able to bear the sympathy they would provide if she broke now. No, she wanted to grieve for Fred in solitude and somewhere far, far away from this killer of a planet.

"I'm going to go up the elevator in a few days," she announced to Jack over dinner. "I want to get as far away from this miserable, hateful, poisonous, cold beast of a planet as I can. We were never meant to be out here so far from Earth, where everything is just waiting to kill us."

"What about your career?" Jack protested. "You can't just throw away those grants. It'd be professional suicide after all the money they spent to get you here."

Helen looked at him with cold eyes. "I think, considering the circumstances, they would make allowances." Surely they didn't expect her to continue after losing her only brother.

"Are you sure that's what it is and not some way of justifying your fears?" Jack asked.

"What? You've decided to go into psychotherapy instead of piloting?" Helen snapped back. "Don't try to analyze me and my motives. How would you feel about losing someone close to you?"

Jack bit his lip. "I did, just in case you forgot. But I came out here to do a job and, by God, I will do it no matter what the old man throws at me. I'm not about to let some overblown planet send me packing with my tail between my legs."

Helen felt her anger grow. "Is that what you think, that I'm running away? Listen to me, I fought like hell to earn my place out here and, no matter how much I was afraid, I was going to stick it out. What I didn't sign up for was risking my freaking life for a few bits of atmospheric data. No sir, it's not fear that's making me leave—it's simple prudence."

"It was a freak accident," Jack argued. "A plane crash could kill that many people, or even a bus wreck. Accidents happen all the time. There isn't anyplace that's completely safe."

"Sure, but the odds are a lot better on Earth. No, Jack, my mind's made up. I'm heading back and to hell with the consequences. At least I'll be alive."

"One last trip," Jack pleaded. "Maybe it'll get your mind off of Beta," he said. "Besides, I need an excuse to get back in my plane and you're the only scientist left on the station."

Helen looked at Jack's tormented features. It was obvious that he needed to get away from the sympathy of the others as much as she. Why not go with him, she thought? Everybody has to deal with loss their own way. Maybe she could find the solitude she needed in the plane's cramped instrument bay. Helen slowly followed Jack to suit up. They ran through the pre-flight checks with the ease of familiar routine.

"Might as well drop a few more probes," Helen remarked when she noticed that the canisters had been loaded. Apparently the station's crew continued on their usual routine despite the tragedy. It was another way of dealing with loss. When Jack acknowledged, she plotted a course that would take them on a long southern sweep.

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She idly glanced out the port as the sailplane dropped away from the station. It seemed impossible that something so massive as the station could have separated from the thick cable that suspended it. Yet it had happened—there was no doubt of that. The elevator crew had reported that the cross beams that had held Beta fast were bent where the station's armature had been torn off the cable. Some brave soul had even ventured out to cut a sample of the beam so they could analyze for the mechanical failure that caused the loss.

The atmosphere was unusually clear today. In the distance she could see the receding line of darkness racing away from them as mighty Jupiter rolled along. They'd be out for eight hours, which meant that they'd return in darkness, not that that was a problem; Jack had proven himself a capable pilot over the past few months and could probably bring them back blindfolded.

"Funny thing," Jack said suddenly over the intercom. "There for a moment I saw something flash in the sunlight off to our right."

"Lightning bolt?" Helen asked. "That's unusual in clear air. Are we approaching a storm center?"

Jack took a moment before replying. "Not that I can see. But it didn't look like that sort of flash. It was more like a reflection off of something."

"I can't think of what it might be. Where was it?" She leaned as close as she could to the right-hand port.

"Down about thirty degrees and just off the nose," Jack directed her eyes. Helen stared at the area he described but saw nothing out of the ordinary.

"Curious," she said and dismissed the incident. It could have been a hunk of ice for all she knew—not unheard of, but rare. Even the flash of a meteorite.

"There it is again!" Jack practically screamed. "Look, look!"

Helen rapped her forehead against the port as she tried to see what had gotten him so excited. Where was it. . . ?

Then she spotted the object. It was a tiny speck far below them, a solid bit of something that was racing back in the direction they had come. She wasn't sure, but it looked sort of cross-shaped. Like a plane.

"I swore we were the only ones going out today," Jack said as he banked the plane to follow the speck. "What do you say we give him a thrill?" There was no mistaking the joyfulness in his voice. He was obviously hungry to use his skills in something besides flying her probe bus.

Helen hesitated. Blacker frowned on such horseplay, and she usually discouraged Jack whenever he suggested it: "What the hell, go for it!" she said with sudden abandon. What could they do to her anyway—this was her last flight, wasn't it? She sat back to enjoy the ride.

Jack tipped the nose down and plunged after the other plane, gaining air speed as they raced to intercept. The other plane couldn't possibly see them approaching from high and to their rear. The plane suddenly jerked to the right and then straightened. "They were turning so I'm trying to stay behind where they can't see me until the last minute," he explained as the plane dipped again. "Boy, I wish I could see their faces when we whip by them." He sounded like a ten-year-old riding a bicycle. All traces of sadness were gone from his voice in the joy of flight.

This must be a catharsis for him, Helen thought and wished that there was something, anything that she could do to achieve a similar release. How nice it must be to feel the wind beneath your wings as Jack did, to be one with the air for a brief while. The plane suddenly leveled off and Helen saw the other plane flash by the port.

"Jesus!" Jack said. "I can't believe it." He pulled the plane up and around in a tight bank that threatened to send Helen's stomach into orbit and its contents into her lap. "Look! Look!"

"How the devil do you expect me to see anything from back here?" Helen

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complained. "What's going on—what's got you so excited?"

"It's from Beta!" Jack yelled loud enough to deafen her. "That's one of their planes!" He wiggled the plane's wings up and down. "Come on, we're leading them home!"

Helen sat back in silent wonder. Could this be Fred's plane? She hoped against hope. Could Fred have somehow, miraculously flown himself out of danger, away from Beta's fatal plunge? She said a small prayer as the plane flew on.

The trip back was an agony of suspense and worry. Helen found herself glancing constantly out of the port in hopes of seeing the other plane, of somehow catching a glimpse of the pilot who was flying it. She kept checking in hopes that the pilot would have Fred's red hair.

But that was silly; Fred would be wearing his helmet. There was no way that she could tell who the pilot was, even if she could manage to see the other plane. *Hurry, hurry*, she whispered to herself, at once anxious and fearful of what she would discover when they arrived.

Jack circled the station as the other plane made itself fast and then he floated theirs into position. Helen was out of the bay and racing down the corridor the instant she heard the locks click home. She threw her helmet and gloves aside, unmindful of where they might land.

She pushed her way through the growing crowd around the lock and stared at the helmet that enclosed the head of the pilot. He acted as if he barely had the strength to pull himself through the hatch. Helen stooped and put her hands under his arms to help him. "Fred?" she said expectantly. "Fred?"

Somebody snapped the helmet loose and Helen saw a cascade of blonde hair spill out. This wasn't Fred. It wasn't Fred.

"There's two more!" somebody yelled from the other lock, the one that opened to the instrument bay. Helen crawled to the rear and saw two weakened people emerge. Neither of them had Fred's red hair.

Fred was dead. Her prayers had not been answered.

The survivors' stories were harrowing. Julia, the pilot, had already been suited up for a flight when Beta started breaking up. She grabbed the nearest three people she could find and tried to shove them into the bay of her plane. But only two would fit. One of them gave her a quick kiss and stepped back. "Good luck," he'd said as the lock sealed. "I didn't even know his name," Julia sobbed through her tears.

Everyone was in awe of Julia's feat. The woman had flown a third of the way around Jupiter, using every jet stream she could find to reach safety. She hadn't slept, hadn't had anything to drink or eat since they left Beta. Somehow she had done it against all odds. Somehow she had gotten her passengers to safety.

"Yeah, I knew Fred," Julia admitted when they had a chance to talk a few days later, after Helen had given up her place on the elevator. "We were good friends," she added simply.

From what she knew of her brother, she knew exactly what sort of 'friend' Julia had probably been. Fred always did have good taste in his women. "What about Fred?" she asked, desperate for some reassurance about her lost brother. "Is there a chance that he could have done the same thing as you?"

"I doubt it," Julia replied after a moment's thought. "He'd been out for a day already. I doubt he'd have the reserves to make it, but he'd die trying. I'm sure of that."

"I never understood my brother's death wish," Helen said suddenly.

Julia smiled through her tears. "Death wish? You didn't know your brother

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very well. Fred was too caught up with his love of flying, his love for this magnificent planet. He told everyone that we were going to tame Jupiter's immensity."

"You loved him," Helen said simply as she reached out and brushed the tears away from Julia's face.

Julia sobbed as she continued, "He made *me* understand that taking the planes out there was the most wonderful thing we could do. He said it was like flying across the face of God himself."

Helen recalled that last conversation she'd had with Fred when he'd asked her why she loved science so much. It sounded as if he remembered. It sounded like he understood.

And now it was her turn to understand.

Helen sat in the galley. She watched the clouds roll by outside the window. Jack flopped into the seat opposite her and rested his chin on his hands.

"Thought you were going up with the others today," he said.

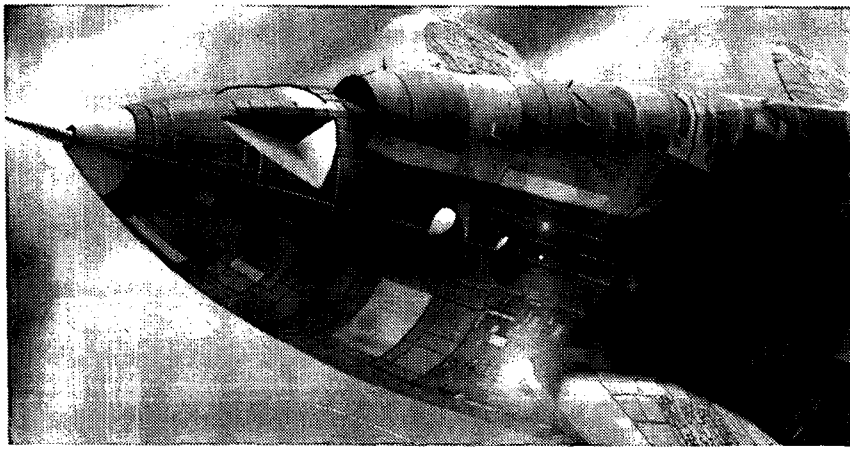
Helen looked away from the window and took a sip of her tea. "Thought I'd stick around and finish the grant. Might as well finish the work I came out here to do." She looked back at the window.

"Great view from here," Jack volunteered as he leaned forward to glance outside. "But not nearly as good as the one from the cockpit. Sometimes it makes me want to cry , it's so beautiful."

Helen nodded. She now understood what Jack felt. Fred had given her that, through Julia. This station, these planes, this entire effort to dredge the secrets from Jupiter's mighty body wasn't just about knowledge and science, it was about the will of humankind to explore, to discover, to achieve. Fred, Julia, Jack, and the others didn't fly these planes around Jupiter just for the money or the science—they flew because they loved this stupid overgrown planet that could kill them. Fred flew because it was thumbing his nose in the face of adversity. Fred flew across Jupiter's face because it was what a human being *could* do.

"If you're ready to go out again," Jack said quietly, "I've got the plane all ready."

She finished her tea and stood up. "Yeah," she replied. "Let's finish what we started." She would go out and continue to discover the wonders of this place. Maybe it wasn't as exciting as Fred's way, but, perhaps it was the way she could find out what it was like to reach out and touch the face of God. ■



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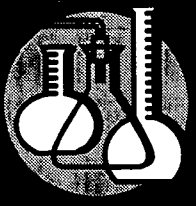
IT'S ANLAB TIME AGAIN



YOUR BALLOT WILL BE AUTOMATICALLY ENTERED IN OUR DRAWING FOR A FREE ONE-YEAR SUBSCRIPTION!

December is our last issue for 1998, and as usual we're asking you to help us via the Analytical Laboratory. Not only will your votes provide tangible awards for your favorite authors and artist, but your feedback will help guide our selections of what to offer you in the future. Your vote is important!

Look over all your copies of *Analog* dated 1998, or refer to the annual index which will appear in our January 1999 issue. Pick your *three* favorites in each of the following categories: novella, novelette, short story, science fact article, and cover. If you're not sure about a piece's category, you'll find it listed in the Table of Contents for the issue in which it appeared, as well as in the Index. In the event of a disagreement between the Table of Contents and the Index, the Index should be considered correct. List your choices in order of preference (your favorite in each category is #1) on the ballot below, and either mail it in or send it by e-mail. The ballot is intended to make it easier for you to vote, but if you don't want to cut it out, feel free to copy it.

To be sure your vote counts, please have it reach us by **February 1st, 1999.**

Please, only vote once! Thank you very much!

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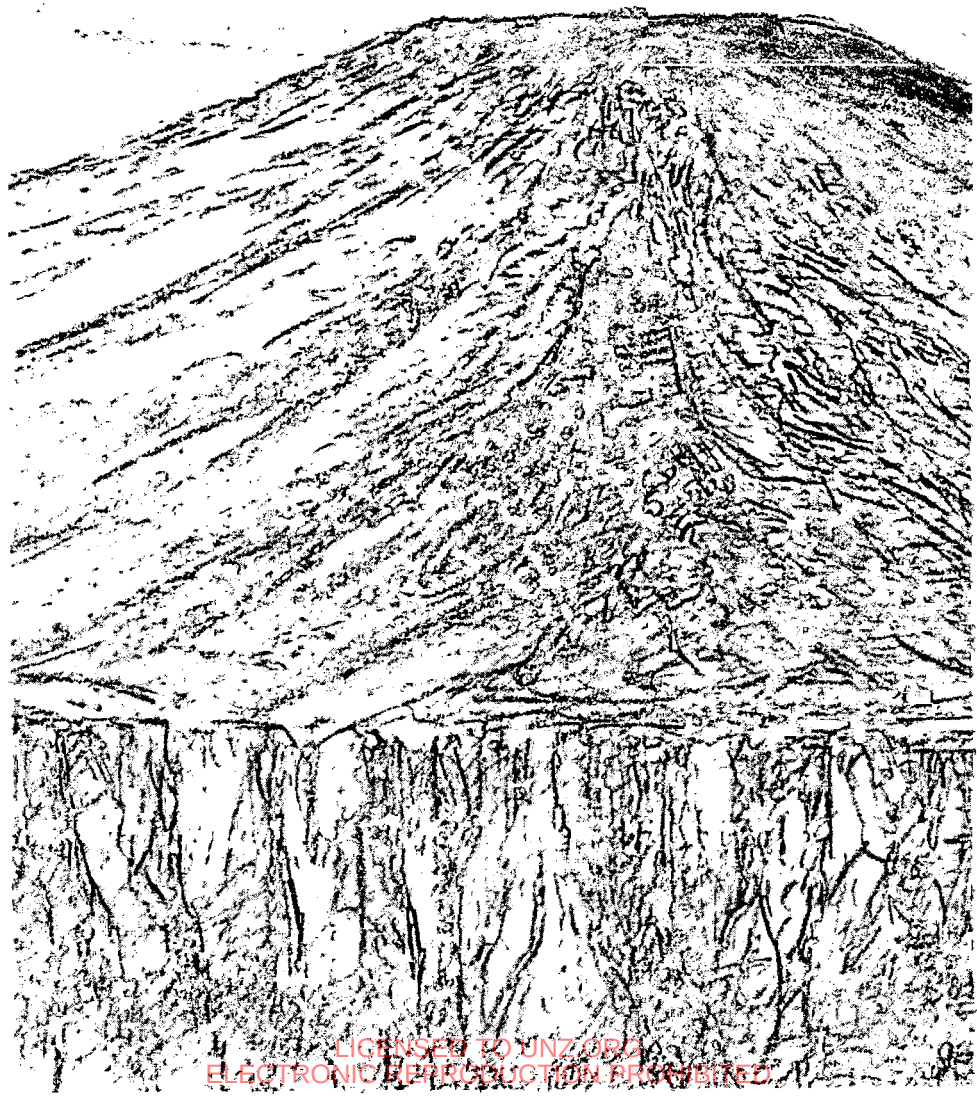
Allen Steele

ZWARTE PIET'S TALE

Frontier folk learn to make what they need—including legends.

Illustration by Bob Eggleton



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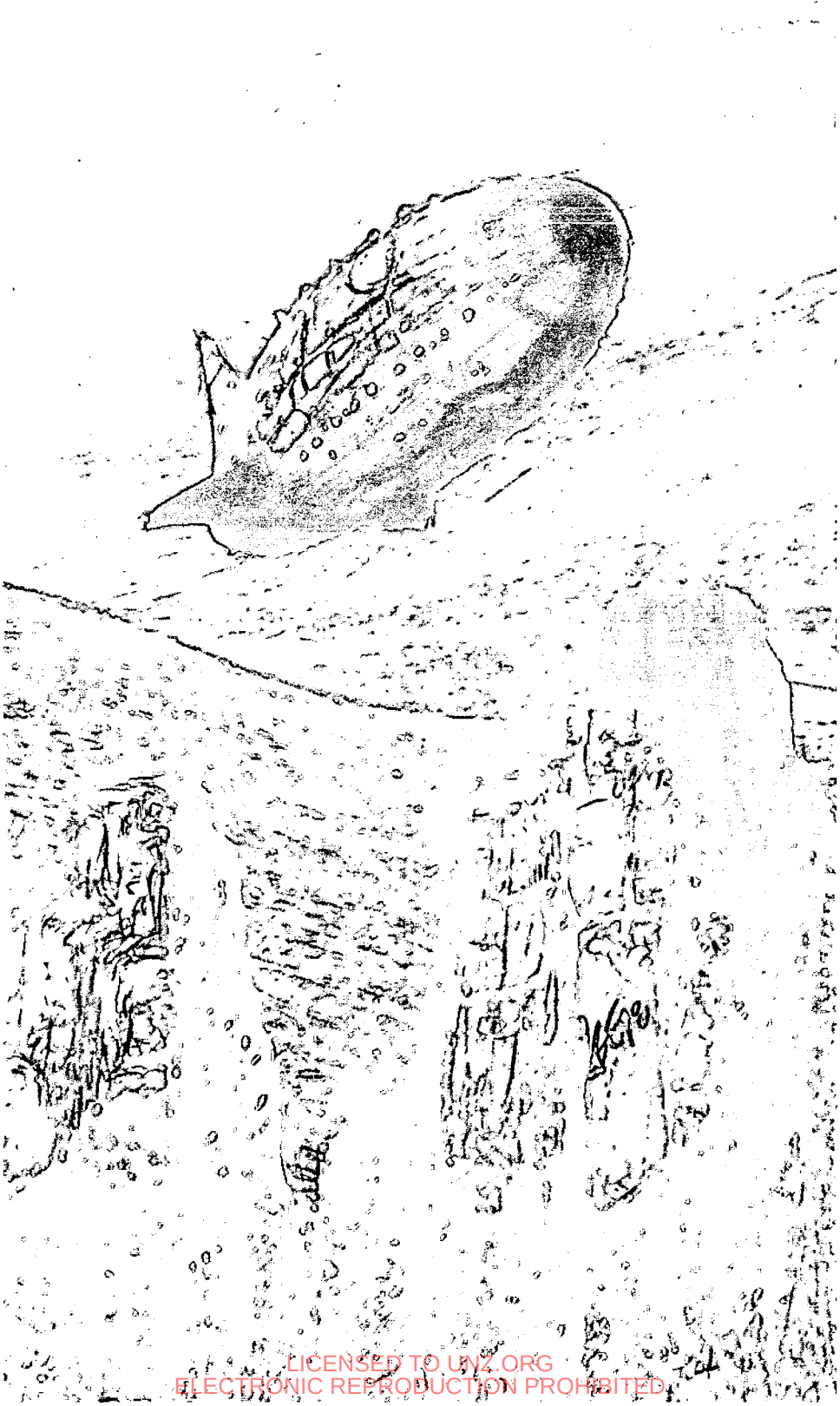

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People often speak of Christmas as being a season of miracles. Indeed, it sometimes seems that's all you hear about during the holiday season; download the daily newsfeed, and you're sure to find at least one doe-eyed story about a lost child reunited with his parents, a stray pet finding his way home, a maglev train that barely avoids colliding with another, a house burning down without anyone being killed. These things can happen at any time, and often do, but when they occur at Christmas, a special significance is attached to them, as if an arbitrary date on the Gregorian calendar somehow has a magical portent.

That sort of thing may go smoothly on Earth, but anyone on Mars who believes in miracles is the sort of person you don't want to be with during a habitat blowout or a dust storm alert. Belief in miracles implies belief in divine intervention, or luck at the very least; that kind of attitude has killed more people out here than anything else. Luck won't help you when a cell of your dome undergoes explosive decompression, but having paid attention during basic training will. I've known devoutly religious people who've died because they panicked when a wall of sand came barrelling across the plains, while atheists who kept their heads and sprinted to the nearest shelter have survived. Four people returning to Wellstown from a water survey were killed on Earth's Christmas Day back in M.Y. 46, when the driver of their rover rolled the vehicle down a twenty-meter embankment; there was no yuletide miracle for them.

I'm sorry if this may seem cynical, but that's the way it is. Almost a million aresians now live on Mars, and we didn't face down this cold red world by believing in Santa Claus. Luck is something you make for yourself; miracles occur when you get extra-lucky. I've been here for over twenty years now, and I've never seen it work differently, whether it be on Christmas, Yom Kippur, or First Landing Day.

Yet still . . . there's always an exception.

Sure, we celebrate Christmas on Mars. We just don't do it the same way as on Earth.

The first thing you have to remember is that we count the days a bit differently. Having 39.6 more minutes each day, and 669 days—or sols, as we call 'em—in a sidereal period, meant that aresians threw out both Greenwich Mean Time and the Gregorian calendar in A.D. 2032, long before the Pax Astra took control of the near-space colonies, way before Mars declared its independence. The Zubrin calendar has twelve months, ranging from 48 to 66 sols in length, each named after a Zodiac constellation; it retroactively began on January 1, 1961, which became Gemini 1, M.Y. 1 by local reckoning. The conversion factors from Gregorian to Zubrin calendars are fairly complex, so don't ask for an explanation here, except to say that one of the first things newcomers from Earth have to realize is that April Fool pranks are even less funny at Arsia Station than they were back in Indiana.

Indeed, aresians pretty much did away with Halloween, Thanksgiving, Guy Fawkes Day, Bastille Day, and virtually every other Earth holiday. Our New Year's is out of whack with the rest of the solar system, and instead of Columbus Day we have First Landing; when Mars seceded from the Pax Astra in 2066, or M.Y. 57, we began commemorating the event with our own Independence Day. A few religious holidays continue to be observed at the same time as they are on Earth. West Bank, the small Jewish settlement on the western slope of the Tharsis bulge, celebrates Hanukkah in accordance with the traditional Hebrew calendar; I was once there for the third night of Hanukkah, and watched as the family with whom I was staying lit its menorah when the colony's DNAI calculated the sun had set in Jerusalem.

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Christmas has been imported as well, yet because the aresian year was nearly twice as long as Earth's, it comes around half as often. The first colonists tried having their Christmas promptly on December 25th, but it felt odd to be celebrating Christmas twice a year, sometimes in the middle of the Martian summer. When the colonies formally adopted the Zubrin calendar in M.Y. 38, it was decided that the aresian Christmas would fall only once two Earth years; this meant that we had to devise our own way of observing the holiday. So instead of designating one single sol in Taurus as being Christmas Day, aresians picked the second week of the month as Christmas Week, beginning on Ta.6 and continuing through Ta.13; it was roughly adapted from the Dutch tradition of observing December 6 as the Feast of St. Nicholas. During that week, everyone would take a break from all but the most essential labor, and this would give families and clans a chance to get together and exchange gifts. Devout Christians who wished to continue unofficially observing December 25 as Jesus's birthday were welcome to do so— New Chattanooga and Wellstown took two sols off each aresian year for a terran-style Christmas—but it wasn't marked on the Zubrin calendar.

Most of the original Seven Colonies, with the exception of West Bank, accepted Christmas Week as a respite from the hard work of settling the Martian frontier. As more immigrants from Earth and the Moon began establishing new colonies along the eastern equator, they adopted Christmas Week as well. Yet, as time went on, the aresian Christmas began to lose much of its original meaning.

Indeed, as some noted, the week never had that much meaning to begin with. Since it wasn't held to celebrate of the birth of Christ, it had little religious significance. Families and clans tended to live in the same colonies, often sharing the same quarters, so there wasn't much point in setting aside an entire week for them to get together. These colonists lived on the verge of poverty; Pax trade tariffs and the enormous cost of importing items from Earth made Christmas presents beyond the reach of most people, and giving someone a new helmet liner is hardly the stuff of romance. So what usually happened during Christmas Week was that people congregated in taprooms to get ripped on homebrew and hempweed; when the taprooms closed, louts roamed the corridors looking for trouble. By mid-century, Christmas Week had degenerated into debauchery, random violence, and the occasional fatal accident. It wasn't a lot of fun.

Worse yet was the fact that the first generation of aresians to be born on Mars was growing up with only second-hand knowledge of what Christmas was supposed to be like. They'd read old microfiche stories about Rudolph and Santa Claus, the Grinch and Scrooge, or watch disks of ancient films like *It's A Wonderful Life* and *Frosty the Snowman*, and then go to their parents asking why Santa didn't drop down their chimney to leave wrapped and ribboned gifts beneath a tree strung with lights and tiny ornaments. Perhaps you can successfully explain to a four-year-old why there aren't any reindeer and Douglas firs on Mars, or even point out that your two-room apartment doesn't have a hearth, let alone a chimney . . . but try telling a small child that there's no such person as Santa.

Mars was in desperate need of a St. Nicholas, a Father Christmas, a Santa Claus. In M.Y. 52, he arrived in the form of Dr. Johann Spanjaard.

Despite the fact that I'm one of the few people on Mars who knew him well, there's very little I can tell you about Doc Spanjaard. That's not much of a surprise, though; folks came here for many different reasons, and not always the best ones. Frontiers tend to attract people who didn't quite fit in the

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places they came from, and on Mars it's impolite to ask someone about their past if they don't voluntarily offer that information themselves. Some aresians will blabber all day about their home towns or their old job, but others I've known for twenty years and still don't know where they were born, or even their real names.

Johann Spanjaard fell somewhere between these extremes. He was born in Holland, but I don't know when: around A.D. 2030 is my best guess, since he appeared to be in his early forties when he arrived at Arsia Station. He was trained as a paramedic, and briefly worked on Clarke County; and later at Descartes Station. He was a Moon War vet; he told me that he witnessed the Battle of Mare Tranquillitatis, but if he had any combat medals he never showed them to me. He returned to Earth, stayed there a little while, left again to take a short job as a beltship doctor, then finally immigrated to Mars. There were at least two women in his past—Anja, his first wife, and Sarah, his second—but he seldom spoke of them, although he sent them occasional letters.

No children. In hindsight, that may be the most significant fact of all: even after marrying and leaving two wives, Doc didn't have any kids. Save that thought.

Doc Spanjaard immigrated to Mars in M.Y. 52, five aresian years before the colonies broke away from Pax. By then Arsia Station had become the largest colony; nearly a hundred thousand people lived in reasonable comfort within the buckydomes and underground malls that had grown up around the base camp of the original American expedition, just south of the Noctis Labyrinthis where, on a nice clear day, you could just make out the massive volcanic cone of Arsia Mons looming over the western horizon. The colony had finally expanded its overcrowded infirmary into a full-fledged hospital, and Doc was one of the people hired to staff its new emergency ward.

I came to know Doc because of my job as an airship pilot. One of Arsia General's missions was providing medical airlifts to our six neighbor colonies in the western hemisphere; although they had infirmaries of their own, none possessed Arsia General's staff or equipment. The hospital had contracted my employer, AeroMars, to fly doctors out to these remote settlements and, on occasion, bring back patients for treatment. Within two sols of Doc's arrival at Arsia General, I flew him over the Valles Marineris to Wellstown so he could treat a burn victim from an explosion at the fuel depot. We ended up hauling the poor guy back to Arsia Station that same day; the sortie lasted twenty-seven hours, coming and going, and when it was over we were too wired to go to bed, so we wandered over to the Mars Hotel and had a few beers.

That trip established a regular pattern for us: fly out, do what had to be done, fly back, hand the case over to the ER staff, then head to the nearest taproom to decompress. However, I seldom saw Doc Spanjaard get loaded; three beers was his limit, and he never touched hard liquor. Which was fine with me; I'm a featherweight drinker myself, and two beers was the most I'd allow myself because I never knew when I'd get beeped to drag *Miss Thuvia* back into the sky again. But the three of us logged a lot of klicks together; once I had the princess tied down in her hangar and Doc had washed someone else's blood off his hands, we'd park our rumps in a quiet bar and tap mugs for a job well done.

We were a mutt-'n-jeff team if there ever was one. Doc was tall and preposterously skinny, with solemn blue eyes and fair skin that helmet burn had freckled around his trim white beard; imagine an underfed St. Nicholas and you've got it down. I was the short, dumpy black sidekick from Tycho City who had a thing for Burroughs classics and loved old Eddie Murphy movies even though I had never spent more than two weeks

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on Earth (what can I say? he made me laugh). But Doc had a wry sense of humor that most people didn't see, and I was the only airlift pilot who wouldn't panic when he had to perform a emergency tracheotomy at twelve hundred meters with a utility knife and a pen.

We saw a lot of action over the course of the next nine months; by my count, we saved at least thirty lives and lost only four. Not bad for two guys whose biggest complaint was losing a lot of sleep. *The Martian Chronicle* caught wind of our act and wanted to do a story on us. We talked it over during a ride back from Sagan, then radioed back to Arsia General and arranged for the reporter to meet us at the Mars Hotel after we got home. The reporter was there, along with his photographer and one of Doc's former patients, a sweet young thing from West Bank whose heart was still beating due to Doc's ministrations and my flying skills, but gee gosh, we forgot where we were supposed to meet them and went to Lucky Pierre's instead. Two more missed interviews, followed by profuse apologies and sworn promises that we'd at the right place next time, went by before the *Chronicle* finally got the message. On Mars, the phrase "mind your own business" is taken seriously, even by the press.

But it wasn't always funny stuff. Our job took us places you'd never want to see, the settlements established along the equatorial zone surrounding the Valles Marineris. Over forty Earth years had elapsed since First Landing, and humankind had made substantial footholds on this big red planet, yet beyond the safe, warm confines of Arsia Station life could be pretty grim. New Chattanooga was infested with sandbugs, the seemingly indestructible mites which lived in the permafrost and honed in on any aquifer large enough for them to lay eggs; the colony's water tanks were literally swimming with them, and despite the best filtration efforts they were in every cup of coffee you drank and every sponge-bath you took. DaVinci was populated by neocommunists who, despising bourgeois culture and counterrevolutionary influences, wanted little to do with the rest of the colonies, and therefore turned down most aid offered by Arsia Station. Their subsurface warrens were cold and dimly-lit, their denizens hard-eyed and ready to quote Mao Tse Tung as soon as you entered the airlock. Viking, the northernmost settlement, was located on the Chryse Planitia near the Viking I landing site: two hundred people huddled together in buckydomes while eking out the most precarious of existences, and every time we visited them, the population had grown a little smaller. And people spoke only in hushed tones about Ascension, the settlement near Sagan just south of the Valles Marineris that had been founded by religious zealots; living in self-enforced isolation, running short of food and water, finally cut off from the neighboring colonies by the planetwide dust storm of M.Y. 47, its inhabitants began murdering one another, then cannibalizing the corpses.

Doc and I saw a side of the Martian frontier that most people on Earth didn't even know existed: hypothermia, malnutrition, disease, injuries caused by carelessness or malfunctioning equipment, psychosis, and not a few deaths. We did what we could, then we flew home and tried to drown our sorrows in homemade brew. There's many wonderful things about Mars, but it's not Earth or even the Moon; this is a place with damned little mercy, and those it doesn't kill outright, it conspires to drive insane.

Perhaps we went a little stir-crazy ourselves, for one night in the Mars Hotel we got to talking about what we missed about Christmas.

It was the third week of Aries, M.Y. 53. Christmas was only a couple of weeks away, and already the taprooms were

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brewing more beer for the festivities to come. We had just returned from delivering medical supplies to the poor schmucks at Viking, and were watching the bartender as he strung some discarded fiberoptics over the bar.

"I miss mistletoe," I murmured. I was working on my second beer by then, so I wasn't conscious of my alliteration. "Mistletoe and Christmas trees."

"You don't know mistletoe and Christmas trees," Doc said.

"Sure do. Had them in my family's apartment. My mother and father, they used to kiss beneath the . . ."

"You grew up on the Moon. You had vinyl mistletoe and plastic Christmas trees. Bet you've never smelled the real thing."

"No, but it was close enough."

"Not in the slightest. You'd know the difference." Doc sipped his beer. "But I get the point. Out in the Belt, we'd get together in the wardroom on Christmas Eve and sing carols. You know caroling. . . ?"

"Sure. 'Silent Night,' 'The First Day of Christmas,' 'Jingle Bell Rock' . . ."

"'Santa Claus Is Coming To Town,' that's my favorite. And then we'd exchange gifts. Sarah gave me a ring with a little piece of gold from an asteroid ore our ship had refined." He smiled at the memory. "Marriage didn't last, but I held onto the ring."

"My favorite was a little rocket from my Dad. I was eight . . . nine, I guess. He made it for me in his lab. About two meters long, with a hollow nose cone. We put a little note with our squid number in the cone, then went EVA and hiked up to the crater rim, set the trajectory, fueled it up and fired it at Earth." Once again, I remembered that little rocket's silent launch, and how it lanced straight up into the black sky over Tycho. "Dad told me that it would eventually get there and land somewhere, and maybe someone would find it and send back a letter."

"Anyone ever fax you?"

"Naw. It probably never got to Earth . . . or if it did, it probably burned up on entry." I shrugged. "But I like to think that it made the trip, and just landed some place where no one ever found it."

"But it meant something, didn't it? Like Sarah's ring. No Christmas gift is ever insignificant. There's always a little of your soul in whatever you give someone." Doc scowled at the lights being strung above the bar. "Here, it's just an excuse for people to get drunk and stupid, and the next day everyone has to apologize to each other. Sorry for banging on your door. Sorry for keeping you awake last night. Sorry for making a pass at your wife . . ."

"What do you expect? Rudolph the green-nosed reindeer?"

"*Red*. Rudolph the *red*-nosed reindeer. Don't they teach you selenians anything?"

"Oh, yeah. Red-nosed reindeer." I polished off my second and last, shoved the mug across the bar. "Yeah, I know, but all that Santa stuff doesn't make a lot of sense out here, y'know?"

"It doesn't? Why shouldn't it?"

I could tell that he was spoiling for a fight. "Aw, c'mon, Doc . . . does this look like Earth to you? Cheststuff smoking on an open fire, jackass stepping on your toes . . ."

"You can't even get the lyrics right! 'Chestnuts roasting on an open fire, Jack Frost nipping at your toes . . .'"

"What's a chestnut?"

"Never mind." He turned away from me. "Jeff, I'll have another one. Put it on his tab."

I didn't object. Doc was in a self-righteous mood; when he was this way, silence was the only way you could deal with him. I helped myself to some fried algae from the bowl the bartender had placed between us while I waited for him to calm down.

"I guess what I miss the most," he finally said, "is the look . . . no, not just the look, the *glow* . . . children have on Christmas morning. Until I came here, I'd never seen a kid who didn't think it

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was the best day of the year. Even out in the Belt, it was something they could look forward to. But here . . ."

"I know what you mean." My gaze wandered to the line of ceramic liquor bottles lined up on the shelf. "The best some of them can hope for is that their folks won't be too hung over to make breakfast for them. I mean, some people try to do better, but . . . I dunno, something's missing."

"I'll tell you what's missing," Doc tapped his finger against the bartop. "It isn't just trees or presents. Magic, that's missing. There's no Sinterklass"

"Yeah. No Santa Claus."

"Did I say Santa Claus? I didn't say Santa Claus. I said Sinterklass."

"There's a difference?"

For a moment, I thought he was going to brain me with his beer mug. "Hell, yes, there's a difference! Sinterklass arrives in Holland on a ship from Spain. He's a tall, slender gent with a long white beard who wears a red robe and bishop's miter. He rides into town on a white horse with his assistant Zwarte Piet, where he gives presents to all the good children on his list. Then he . . . what's so damn funny?"

"That's Santa Claus, you quack! Only the details are different! Reindeer, elves, a sleigh from the North Pole . . . it's still the same mook, right down to the extortion racket."

"True, but Sinterklass came first . . . or St. Nicholas, if we want to call him by his proper name." He swigged his beer. "He was brought to America by the Dutch, but just like everything else brought over from Europe, he was changed until virtually no one remembered his origins."

"Tell me about it. Same thing happened to my African ancestors . . . although not by choice."

"Then you'd appreciate the similarity between Santa's elves and Zwarte Piet. It means Black Peter . . . he's a Moor."

I shrugged. "Sounds like a demotion. My great-grandfather used to play Santa every Christmas at a shopping mall. There weren't many of them black Santas back then, I'm told."

"Your grandfather played Santa Claus?" He raised an eyebrow. "Now there's a coincidence. My father played Sinterklass in our village, as did my grandfather."

"No kidding?"

"Goes with the genes." He stroked his trim white beard. "Men in my family have the right whiskers for the job. All we have to do is let our beard grow out and . . ."

He stopped just there. To this day, I'll never forget his slack-jawed expression as he stared at me in wonderment. He had just spoken of the glow that children have on Christmas morning; in that instant, I saw something like that appear in his own face. Wonder and joy, wonder and joy; tidings of wonder and joy . . . I don't believe in telepathy any more than I do in Santa Claus, yet I suddenly knew exactly what he was thinking.

"Oh, no, you don't," I said, turning to hop off the stool and book out of there. "Don't even think for a minute . . ."

"Oh, shut up and sit down." Doc grabbed my wrist before I could make it to the door. "Let's see if we can work this out."

Against my better judgement, I stayed. Doc finished his beer, and then we switched to coffee, and by the end of the evening I had a new name.

Sinterklass and Zwarte Piet live in the caldera of Olympus Mons, within an invisible buckydome which contains their secret toyshop. When they're not making toys or teaching sandbugs to perform tricks for their flea circus, they watch all the boys and girls of Mars through magic telescopes that can peer through walls, putting together a long list of who's been naughty and who's been nice.

Then, on the first sol of Christmas Week, they load their gifts aboard their airship, climb aboard, and fly away from

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Olympus Mons. Over the next seven sols they visit the colonies one by one, stopping at each to distribute presents to the good children of Mars. They may stay overnight at a settlement, because sometimes Black Peter gets too tired to fly St. Nicholas to the next colony, but if they do stay, the children should try to leave the pair alone, or next Christmas they may find the boots of their skinsuits filled with sand instead of candy.

That's the story that we artfully disseminated through the Marsnet. It was posted on all the usual sites kids would mouse, plus a few that their parents would find. It isn't hard to create a myth, if you know what you're doing, but Doc and I didn't do it all by ourselves, and not without running into a little trouble.

Arsia Station's board of selectmen were skeptical when we formally pitched the idea to them at the next weekly meeting. They thought Doc and I had dreamed this up as a sneaky way of earning overtime until Doc explained that we would also be transporting food, medical supplies, and replacement parts to the settlements. Not only that, but since we would hitting each settlement in turn, we could take stuff from one place to another, in much the same way supply caravans presently operated, yet in a shorter time-span and for more charitable reasons. The selectmen were all too aware of the ill-will some of the smaller settlements felt toward Arsia; our plan would make for good colonial relationships. So they found a few extra megalox in the budget to fund an extended medical sortie, not the least of which was subcontracting *Miss Thuvia* from AeroMars for a seven-sol flight.

When we contacted the other five colonies and informed them of our proposal, we received mixed reactions. Wellstown, Sagan, Viking, and New Chattanooga were mystified by the notion of a Martian Santa, but otherwise interested, albeit not wildly enthusiastic; if anything, it meant they would receiving a previously unscheduled visit from Arsia General, and a few freebies to boot. West Bank was initially cool to the idea—they didn't observe Christmas Week, after all—until we agreed to knock off the Sinterklass routine and perform as if it was just another airlift. But DaVinci was the aresian home of Ebenezer Scrooge; after a few days of stone silence, we received a terse fax from its Proletariat, stating that the free people of DaVinci had decided to reject St. Nicholas was an archaic symbol of capitalistic society and Black Peter as a shameful holdover of racist imperialism. Well, tough boots: no candy for the commies.

Most people went for it, though, and once word leaked out about what Doc and I intended to do, we received assistance from various individuals, sometimes without us soliciting them for help. Aresians have a strong tradition of looking out for the other guy, after all, and the citizens of Arsia Station came out for us. A textile shop volunteered to make toys for us: tiny Mars landers, statuettes of men in skinsuits, some inflatable replicas of *Miss Thuvia*. A food-processing firm turned out several kilos of hard candy; it looked weird and tasted the same, or at least so I thought, but Doc field-tested samples on kids passing through the ER ward and none of them spit it out. A lady I was dating from Data One hacked out a game pak which she stored on a handful of spare disks; one of them was a little hide-and-seek involving Sinterklass and Zwarte Piet chasing each other through a three-dimensional maze. She made sure that the odds of Black Peter winning the match were always in my character's favor, something which Doc resented when he tried playing it.

Yet the best efforts were those on behalf of our skinsuits. It wouldn't do for us to cycle through airlocks looking like any other dust-caked aresian coming in from the cold. Sinterklass and Zwarte Piet were magical, after all; we had to look the part. So we hired Uncle Sal, Ar-

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sia's premier skinsuit tailor, to come up with a some hempcloth overgarments which closely mimicked the traditional costumes worn in the Netherlands. Doc's outfit was bright red and white, with a long scarlet cape whose ribbed hood, when pulled over his helmet, looked much like a bishop's miter. My costume was dark blue, with a plumed white collar around the neck and puffed-out sleeves and leggings. To add to the effect, Sal weaved colored microfilaments through the garments; when we switched them on, we looked like walking Christmas trees.

The only problem we had was with Doc's beard. He stopped trimming it once our plan was approved, and within a couple of weeks it flowed down his face like a pale waterfall. It looked terrific and his girlfriends loved running their fingers through it, but he had the damnedest time tucking it into his helmet. He finally figured out what that hearty "ho-ho-ho" business was all about; it allowed him to spit out the whiskers in his mouth.

Altogether, it was an impressive effort, doubly so by the fact that we pulled it all together in less than three weeks. On Ta. 6, M.Y. 53, Doc and I climbed aboard *Miss Thuvia* and set sail from Arsia Station. The blimp had been temporarily festooned with multicolored lights. I turned them on as soon as we were clear of the hangar, and watched from the gondola windows as a small crowd of aresians waved us farewell.

It was a good beginning, but our first stop, at twilight on the first day of the tour, was a bust. West Bank didn't want anything to do with Christmas, so I kept the lights turned off when we approached the settlement on the western slope of the Tharsis volcano range, and we weren't wearing our outfits when we exited the blimp's airlock. The settlers were cordial enough; we handed out sweets and toys to the handful of kids we met inside, and once their folks unloaded the supplies they had requested—which wasn't much, because West Bank took pride in its self-sufficiency—we had a meal and a glass of wine in the commissary before we were shown the way to the hostel. Nothing lost, but nothing really gained either, save for fuel and a night's rest; by dawn the next morning we were airborne again. The only thing which made the trip worthwhile was seeing the sunrise over Pavonis Mons as we flew eastward toward the upper edge of the Noctis Labyrinthis.

That was the longest leg of the journey. Over a thousand klicks lay between West Bank and Wellstown, and although Doc stood watch in the cockpit while I bunked out for a couple of hours, I did little more than doze. Questions ran through my mind even while my eyes were shut, murmuring like the incessant drone of *Miss Thuvia*'s props. What were we doing, two g.own men dressing up like the Dutch Santa and his Moorish apprentice? I could be home now, trying to find an unattached lady with whom I could share some holiday cheer. What were we trying to achieve here? The children at West Bank had shown only slight interest in us; a little girl had stoically gazed at the toy lander Doc placed in her hand, and a small boy had made a sour face when he ate the candy I had given him. Yeah, so maybe Christmas wasn't part of their culture, but the Jewish friends with whom I had been raised on the Moon knew what it was, if only for the spirit of the season. Perhaps Christmas didn't belong on Mars. So why did any of this matter?

When I finally got up and went forward, I could see that Doc had been contemplating the same thought. "It'll go better in Wellstown," he said softly, but I don't think he believed it either.

We ate cold rations as the sun went down behind us, drank some more powdered coffee, and said very little to one another until the lights of Wellstown appeared before us, a tiny cluster of white and amber lights against the

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cold darkness of the Martian night. Almost reluctantly, we pulled on our skinsuits. I almost forgot to switch *Miss Thuvia*'s Christmas lights until we were above the landing field.

A handful of men grabbed our mooring lines, dragged us in, tied us down. It was only the second time we had worn our costumes on EVA; Doc stepped on his cape and nearly fell down the gangway, and the puffed-out legging of my suit forced me into a bow-legged gait. We looked stupid as we made our way to the airlock of the nearest buckydome. The final touch came when Doc couldn't fit inside, and he had to lower the peaked hood of his cape.

The outer hatch shut behind us; we got a chance to study each other as the airlock cycled. Two fools in gaudy, luminescent skinsuits. A bad dream come to life. We had been flying for the past twelve hours, but I would have gladly flown straight home if I thought it would save me any further humiliation. Why did I ever let Doc talk me into. . . ?

Then the green light flashed above the inner hatch. Doc and I were unclasping our helmets when the lockwheel began turning on its own. Then the inner hatch was thrown open from outside. Bright light rushed into the airlock, and along with it, the excited squeals of the dozens of children waiting outside.

At that instant, it all made perfect sense.

Even after all these years, I still consider that first Christmas tour to be our best. We ran short of candy and toys before we were through, and we were bone-tired by the time we left Sagan for the last leg of the circuit back to Arsia Station, yet we brought home with us the most exciting discovery since microfossils were found in the Noctis Labyrinthis.

St. Nicholas was alive and well and living on Mars. How could nearly three hundred kids possibly be wrong?

Sometimes it was tough. The children at Viking broke our hearts: grimy, hungry, wearing cast-off clothes, but enchanted the moment we stepped through the airlock. None rejected our awful candy, and they fought jealously over the crude toys from Doc's bag until we made sure that everyone had something to take home. They took turns sitting in Sinterklass's lap, and he listened to stories of hardship and loss that would have horrified the worst curmudgeon. Several kids were sallow and feverish with lingering illnesses that required Doc to play physician as well as holiday saint; we were prepared for that, so after a sneaky sort of examination ("How long is your tongue? I bet you've got the longest one here. Open your mouth and let Sinterklass see. Oh, yes, you do, don't you. . . ?") he'd send the sick ones over to Black Peter for a card trick and a couple of pills; later, we'd give the rest of the prescription to their parents.

Sometimes it was funny. A little girl in New Chattanooga was adamant in her outspoken belief that Sinterklass was a fake; the brat kept yanking at Doc's beard, tearing out white hair by its roots in her dogged attempt to dislodge his mask. She got candy and a toy—no child came away empty-handed during that first tour—but before we left the following morning I tracked down her skinsuit in the community ready-room and filled her boots with handfuls of sand. She was much nicer to us the next year. Sagan's resident nymphomaniac decided that the holiday season wasn't complete until, in her words, she had "made Santa's bells jingle." She started by sitting in his lap and whispering something in Doc's ear that succeeded in turning his nose bright red. At any other time, Doc might have obliged, once they were safely away from the little ones, but he decided that this might set a bad precedent. To her credit, she took his refusal with good grace . . . and then she asked me why I was called Black Peter.

And, yeah, sometimes it was scary. A

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slow leak in one of her hydrogen cells caused *Miss Thuvia* to lose altitude as we were flying from Viking to New Chattanooga. The pressure drop occurred while we were flying over Cupri Chasm, one of the deepest parts of the Valles Marineris; for a few minutes, it looked as if we would crash in the red-rock canyon dozens of kilometers below us. I awoke Doc from his nap and he scrambled into the gondola's rear to open the ballast valves. When that wasn't enough, he shoved some cargo containers out the airlock—including, much to our regret, one containing several bottles of homemade wine we were freighting from Wellstown to the other colonies. We jettisoned enough weight from the princess to keep her aloft just long enough to clear the chasm, but she left skid marks when she landed at New Chattanooga. And then we had to put on our costumes and pretend that we hadn't just cheated death by only a few kilos.

But it was fun, and it was exhilarating, and it was heartwarming, and it was *good*. Even before we arrived back at Arsia Station, where we were greeted not by the small handful who had witnessed our departure a week earlier but by hundreds of skinsuited colonists who surrounded the crater and threw up their arms as *Miss Thuvia* came into sight, Doc and I swore to one another that we'd make the same trip again next year.

It wasn't because our newfound fame—we still ducked the *Martian Chronicle* when it came to us for an interview—or the lure of adventure, or even another shot at our cuddly friend in Sagan. It was simply because we'd brought something pure, decent, and civilized to Mars. Perhaps that was a Christmas miracle in itself. If so, then we wanted another one, and another one after that.

We'd eventually received our miracle. But it wasn't one I would have ever expected.

* * *

In 2066, the Pax Astra underwent a political upheaval when the Monarchists overthrew the ruling New Ark Party on the Clarke County space colony near Earth. The coup d'etat was led by former New Ark members frustrated with the economic stagnation brought on by the Pax's government by consensus. They formed an opposition party with the intent of recasting the Pax Astra as a democratic monarchy, and eventually deposed the New Ark in a near-bloodless revolution. Yet shortly after Queen Macedonia had been crowned, the aresian representatives to the new Parliament realized that Martian interests were a very low priority in the new order. The diplomats caught the next cycleship home; no sooner had they arrived at Arsia Station that they formally announced that Mars was seceding from the Pax Astra and that its colonies were declaring political independence.

This was the beginning of the great Martian immigration. Within a year, our world began receiving the first shiploads of refugees from the Pax. Most were New Ark loyalists who had quickly discovered that Monarchist democracy was restricted to those who supported the royal agenda, which mainly involved keeping itself in power and persecuting anyone who objected. Since the Moon was part of the Pax and life on Earth was intolerable to those who had been born in low-gee environments, Mars became their only sanctuary.

But we hadn't built a Statue of Liberty anywhere on our planet, and even Arsia Station was ill-equipped to handle the dozens, then hundreds, of refugees—drybacks, if you want to use the impolite term—who came to us during the long winter of M.Y. 57. Human survival on Mars has always been a frail and precarious matter; even with mandatory water rationing and voluntary birth control, the six colonies were unable to support everyone from the Pax who wanted to move here. Ascension was reopened and West Bank relaxed its

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standards to admit non-Jewish immigrants. When their resources were exhausted, the colonies sent messages to the Pax pleading for it to stop sending more bodies our way. Yet the Monarchists turned a deaf ear to us; since Mars was no longer within the Queen's domain, it was a convenient dumping ground for its dissidents, lowlifes, and criminals. When its escapees began to include people they wanted to keep to themselves, they revoked exit visas and began searching outbound vessels. But they couldn't stop everyone from leaving, and it was a rare week when the contrail of another lander wasn't spotted streaking across our pink skies.

Some of the newcomers came equipped to establish new settlements; this was how we got Nova America in the Solis Planum south of Arsia Station, Graceland in the Margaritifer northeast of New Chattanooga, and Thankgod up on southern edge of the Acidalia Plantia. Others arrived with little more than a second-rate skinsuit and a handful of useless Pax lox that the Mars colonies had stopped accepting as hard currency. They often came down in cramped landers stripped of all but the most essential hardware. Many arrived safely; one way or another, they managed to survive, even prosper. But a few crashed in remote areas. Decades later, explorers were still finding their remains: sad and lonesome skeletons, desiccated by dust storms, half-buried within cold red drifts.

As the month of Taurus rolled around once more, Doc and I found little free time to prepare for Christmas Week. I had received paramedic training by then, so I could assist Doc when we flew out on a sortie; good thing, too, because Arsia General's resources were stretched to the limit. Besides the fact that many immigrants had sustained injuries during landing, just as many had become ill during their long flight from near-space. Radiation sickness, calcium deficiency, dysentery, bronchitis, malnutrition, Tibbet's disease, a half-dozen different strains of influenza . . . you name it, they had it. We had already logged sixteen hundred hours aboard *Miss Thuvia* by Christmas, and were seldom seen in the bars at Arsia Station.

Yet just because the colonies were in crisis didn't mean that Sinterklass and Zwarte Piet got a break. Indeed, their presence was needed more than ever before; the children whom we had visited during our first tour were now teenagers and young adults, but their ranks had been filled by yet more kids, many of whom were toddlers born on Clarke County and the Moon. Uprooted from their homes by the Monarchist revolution, bewildered and frightened by their harsh new environment, some sick, most living in awful poverty, they needed Christmas just as much as they needed air, food, and medicine.

Our annual Christmas tour had become a major part of aresian life by now. The West Bank elders finally decided that a little gentile culture wasn't such a bad thing after all, so they allowed us to wear our costumes when we came to call, and since DaVinci's socialist government had crumbled a couple of years earlier, St. Nicholas and Black Peter were now welcome as the next stop after Viking. Along with the revived Ascension colony and three new settlements, the tour now had nine stops, not including our home port at Arsia Station.

This meant that Doc and I spent the entire holiday week on the road, sometimes making two stops a day. Fortunately, the older colonies had learned to not depend upon Arsia Station to make the holiday season for them; as well as offering room and board if we stayed overnight and refuel *Miss Thuvia* when she touched down, they began making gifts of their own for their neighbor settlements. Since *Miss Thuvia* has a limited payload capacity, and therefore couldn't haul thousands of kilos of Christmas presents from one settlement to another, a rather clever system of gift-giving had

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been devised: each colony gave presents to the next settlement on our route. Arsia Station gave to West Bank, West Bank to Wellstown, Wellstown to Viking, Viking to DaVinci, and so forth. Every other year, Doc and I reversed the schedule so that DaVinci gave stuff to Viking, etc. And the gifts themselves ranged from the simple to the elaborate. West Bank made wonderful handcrafted dreidels that spun forever, Wellstown could be depended on to supply excellent wine, DaVinci distributed illustrated chapbooks of poetry and short stories, Viking's artists contributed tiny yet endlessly fascinating sand paintings, and Sagan's gliders could fly for almost a quarter-klick. And, of course, Arsia Station continued to send candy and small toys to every child who wanted one.

The new settlements were still too impoverished to spend the time or energy to making gifts of their own, though, so I sent email to representatives at each of the older colonies, telling them that Black Peter would be reserving a little extra cargo space aboard Sinterklass's magic dirigible for gifts to Ascension, Nova America, Graceland, and Thankgod. No one objected to the deviation from standard operating procedure, and we were promised extra goodies from everyone when *Miss Thuvia* lifted off from Arsia on Sag. 6.

For the past four years, the Christmas tour had been blessed with good flying weather. Our luck couldn't last forever, though; by the time we arrived at DaVinci, Marsnet had posted nowcasts of a severe dust storm developing in the Amazonis Plantia, due west of the Tharsis Montes range. West Bank, which we had left only eighteen hours earlier, was already reporting high winds. They warned us that *Miss Thuvia* wouldn't be able to handle the storm, and suggested that we deflate our craft and hunker down at DaVinci until the worst was over.

That might be good advice at any other time, but during Christmas Week it posed a real problem. Dust storms have been known to last for days or weeks, even months on certain historic occasions. If Doc and I chose to ride out the storm in DaVinci, we might be celebrating New Year's there. About two dozen immigrants in Thankgod were barely holding out in shelters little more sophisticated than those built by the First Landers; they were in dire need of the food, water, and medicine aboard *Miss Thuvia*. And we quietly regarded DaVinci as our least favorite of stopovers; we hadn't forgotten the snubbing we'd received during our first tour, and more than a few hard-line neocommies still hadn't warmed up to us.

We managed to get the station manager to loan us a long-range rover. It was about six hundred and fifty klicks from DaVinci to Thankgod, but since the rover burned methane/oxygen and carbon dioxide, it was capable of manufacturing its own fuel from the atmosphere and from recaptured water vapor from the condensers, and ditto for cabin air. Using the rover would be slower than taking the blimp, but flying *Miss Thuvia* in this sort of weather was out of the question. The rover had a top speed of seventy klicks per hour, so the round-trip to Thankgod would take about nineteen or twenty hours. If we budgeted two hours for our appearance at Thankgod and added two more as a fudge-factor, and with luck—there's that word again—we'd only lose a sol. Thus we figured the storm should blow itself out by the time we made it back to DaVinci; then we'd be able to reinflate the blimp and head for New Chattanooga.

The kids at the remaining colonies on our tour might have to wait a bit for their Christmas, but there were limits to even Sinterklass's magic. However, we had little doubt that we'd make it to Thankgod.

That's what we told ourselves. In hindsight, I think we were counting on miracles we hadn't earned.

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* * *

So Doc and I loaded our stuff into the rover and set out from DaVinci near the middle of the same sol. The wind was already rising from the west as we followed the line of compacted rover tracks away from the colony into the high country northeast of the Valles Marineris. We hadn't covered a hundred klicks before Doc had to switch on the windshield blowers.

Well, no problem. You've seen one dust storm, you've seen a dozen. I brewed some more coffee, then sacked out in the shotgun seat. When I woke up, my first thought was that I had overslept and that night had already fallen, until Doc told me that it was only late afternoon. The road had completely disappeared behind rippling curtains of red sand; despite the rover's lights, visibility had diminished to only a few meters ahead of the front bumper.

We were driving into the throat of the worst winter storm in . . . well, forget the stats. It was nasty, and that's all there was to it.

Yet we weren't worried. Not really. We had a clear satellite fix on our location, so there was no real danger of getting lost out here. Although our ground speed had dropped to fifty klicks, the rover's six tandem wheels continued to move through the dense sand that scurried around us. We had air, we had hot coffee, we had Nashville music on the CD player; the howling wind buffeted the rover as if it was a boat on high seas, but it was Christmas, and we were Sinterklass and Zwarte Piet. We couldn't be stopped, storm or no storm.

I had just switched off with Doc, and he was rummaging through the food locker in search of cold rations which wouldn't taste too much like cardboard, when we received a microbeam transmission from Arsia Station. I thought it was just a courtesy call: the folks back home making sure we weren't in trouble. The reception was bad, and I was fumbling for a headset when Doc came forward and told me to keep my hands on the yoke, he'd take care of it.

I didn't catch most of it; my attention was focused on avoiding boulders and craters. Doc played the keys until he got a semi-clear channel, listened for a few minutes, scribbled some stuff on a pad, murmured a few words, then clicked off and turned to me.

"Problem."

"Big or small?"

"Dunno. Phobos Station spotted a lander making atmospheric entry about a half-hour ago. Probably from a Pax freighter that made orbit earlier today. Arsia Traffic locked onto its transponder and followed it down until they lost it in the storm."

"Where did it come down?" Then I shook my head. "Oh, no. I can guess this one . . ."

"Edge of the Acidalia, about a hundred and fifty klicks southeast of Thankgod."

"Aw, for the love of . . ."

It figured this might happen, if only because it had happened before; the commander of a Pax refugee ship tried to drop his lander on one of the new colonies without first informing Arsia of his intentions. Pax Royal Intelligence, in an attempt to stop the hemorrhage of its best and brightest from Clarke County and the Moon, had recently begun spreading ugly rumors that we'd launch missiles at any immigrant ships arriving in aresian space. This played into the hands of freighter captains taking aboard drybacks as unlisted passengers; they'd load them aboard a lander, drop 'em near a new settlement, then swing around the planet, make a periapsis burn, and scoot for home before anyone was the wiser. The commander and his crew make out like bandits from the megalox they've taken from their desperate passengers; meanwhile, we're saddled with another dozen or so immigrants who didn't know they were being taken for a ride, both literally and figuratively.

Only in this case, the freighter captain

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had deposited his human cargo in the middle of the a dust storm. Perhaps he wasn't fully aware of the ferocious nature of the Martian climate, but I couldn't bring myself to give him to benefit of the doubt. More likely he knew that dead men don't tell tales, let alone disclose ship registry numbers.

I was still fuming about this while Doc played with the high-gain. "I've got something," he murmured after a few moments. "Weak, but it's there."

"Vox or transponder?"

"Transponder. You think we're going to get local vox through this shit?"

Good point. Unless the drybacks were bouncing signals off one of the satellites, they probably couldn't transmit anything through the storm. Landers that came down intact, though, were programmed to broadcast a shortwave distress signal as soon as they touched down, even if it was only a repeating Morse-code dit-dot-dit that could be received for hundreds of kilometers. "Mayday cast?" I asked, and Doc nodded without looking up. "Can you get a lock on it?"

Doc dickered with the keypad a little while longer before he spoke again. "Yeah, got it. I'm feeding the coordinates to your board."

A topo map appeared on the flat just above the yoke. The signal source was approximately a hundred and fifty kilometers east-southeast of Thankgod, about forty klicks west of our beeline from the colony. Doc looked at me, I looked at him, and that was it. We didn't even discuss the matter; there was no question of whether or not we'd head for the crash site. We were Sinterklass and Zwarte Piet, but before that we were meds, and this is what we did, plain and simple.

"Pain in the ass," I murmured as I began punching the new coordinates into the nav system.

"Yeah. Kind of screws up Christmas, don't it?" Doc lurched out of his seat and headed aft again. "So what do you want? Cheese and tomato, ham and cheese, or turkey?"

It was close to midnight when we located the downed lander.

One moment, it wasn't there; the next, it was in our high-beams, a gargantuan manta ray that had mysteriously been thrown across space and time. Its starboard landing skid had buckled during touchdown, so the craft listed sharply to one side, its right wing half-buried in the sand, the wind driving dust into its engine intakes. The cockpit faced away from us, but there was a dim glimmer of light from within the main hatch porthole.

I halted the rover about ten meters away, and tried one last time to raise someone on the radio. As before, there was no answer; not surprising since the ship had sustained heavy damage during landing. I went aft and found that Doc had already suited up. Until that moment, it hadn't occurred to either of us to strip off all the Father Christmas stuff, but now we didn't have the time nor inclination. So we switched on the holiday lights so we could see each other better in the darknes. Doc raised his hood and picked up his medical bag, then we cycled through the airlock.

We made our way to the lander with our heads down, our arms raised to shield our faceplates against wind-blown silt and gravel. Glancing back, I could make out the rover only by its lamps. I doubted that anyone within the lander had heard our approach through the storm. If, indeed, there were any survivors.

Typical of Pax spacecraft, the airlock was only large enough to accommodate one person at a time. I went first; Doc waited outside while I closed the outer hatch. The light we'd seen outside came from an emergency lamp in the ceiling, but there was sufficient power in the backup electrical system to allow me to run the cycle-through routine. I went by the book, though, and didn't unlatch my

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helmet even after the green light appeared above the inner hatch.

For a moment, there was only darkness when I pushed open the hatch. Then a half-dozen flashlight beams swung my way, and muffled voices cascaded from the gloom:

". . . opening! Look, the hatch. . . !"

". . . the hell, where did he come. . . ?"

". . . it's a man! Daddy, there's a man in . . . !"

". . . everyone, stand back! Get back from the. . . !"

"It's OK. Everything's all right!" I raised a hand against the sudden glare. "I'm from Arsia Station! I'm here to rescue you!"

They couldn't hear me, of course; they were all shouting at once, and my voice didn't carry well through the closed helmet. Yet there were at least a dozen people in here, shadows backlit by flashlight beams. Moving awkwardly against the sloped deck, I stepped the rest of the way out of the airlock, then turned to close the hatch behind me.

Something slammed against my shoulder, hard enough to make me lose my balance. I collapsed against the airlock hatch. It fell into place, then a hand grabbed my shoulder and twisted me around, shoving me back against the portal.

"Don't move!" a voice yelled at me. "Keep your hands where I can see 'em!"

"Hey, cut it out!" I yelled back. "I'm just trying to. . . !"

There's nothing like having a gun shoved in your face to kill conversation. Even in the dim light, I could make out the maw of a Royal Militia blaster, a miniature particle-beam cannon capable of ending all debate over my hat size.

The guy holding it didn't look too pleasant, either: a large gent with a selenian helmet tan, his dark eyes narrowed with rage. His breath fogged my faceplate—it must be pretty cold in here for it to do that—but above the heavy sweater all he wore was a blue uniform jacket. Its epaulets told me it was from the Pax Astra Royal Navy. I had a hunch that it wasn't military surplus.

"Kyle, cut it out!" A woman's voice somewhere behind the ring of flashlights. "Can't you see he's. . . ?"

"Shut up, Marcie." Kyle let go of me and backed away a few centimeters, but kept his weapon trained on my face. "OK, Mars boy, I.D. yourself."

I took a deep breath. "Look, calm down, OK? Don't shoot. I'm not here to . . ."

"Jeez, lieutenant, let him take off his helmet." This from another man elsewhere in the compartment. "How can you hear him?"

"Kyle . . ." Marcie said.

"Everyone shut up!" Kyle braced his feet against the deck. "All right, open up . . . slowly."

"OK, all right. Take it easy." I slowly moved my hands to my suit collar, began unlatching the ring. I heard a child crying from somewhere in the darkness.

I was getting a bad feeling about my friend Kyle. If he was a former PARN officer, then he was doubtless a deserter. Worse, he had most likely heard the Pax agitprop that aresians are cannibals who raid dryback landers. My Christmas gear didn't help matters much; it wasn't your usual standard-issue skinsuit, so to him I probably looked like the Martian equivalent of a wild native wearing a grass skirt and a shrunken head. The man was desperate and afraid, and hiding his fear behind a gun.

"Look," I said once I had removed my helmet, "you're not in any danger, I promise you. We're a med team from Arsia Station. Our rover's just outside. We picked up your transponder signal and . . ."

"There's more than one of you?" His eyes flickered to the hatch behind me. "How many are out there?"

Great. Now he thought he was surrounded. "Just one other guy. I promise you, we're not armed. Please, just put down the gun and we can see about getting you out of this jam, OK?"

"Kyle, would you listen to him?" The

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woman who had spoken before, Marcie, stepped a little closer. Now I saw that her neck was wrapped in thick swatches of torn fabric. A crude neck brace; she probably suffered whiplash during the crash. "He doesn't mean us any harm, and we're . . ."

"Dammit, Marcie, did you hear what he just said? Nobody drives from Arsia Station in a rover. If there was going to be rescue mission, why didn't it come from Thankgod?" Kyle's gun didn't budge an millimeter. "I'm not about to take this guy at his word. He's just going to have to . . ."

Whatever Kyle was about to propose that I do—I suspect it wasn't pleasant—it was forgotten when the hatch suddenly clunked.

Everyone heard the sound. They froze, staring past me. I felt the hatch nudge my back, and I automatically moved aside before I realized what I was doing.

"Doc," I yelled, "don't come in!"

"Shut up!" Kyle shifted his gun first to cover me, then aimed it at the hatch. "You there, listen up! I've got a gun on your pal, so you'd better stop right. . . !"

"Ho, ho, ho! Mer-r-r-ry Christmas! Mer-r-r-r-r-r-ry Christmas!"

Then the hatch was pushed fully open, and in walked Sinterklass.

Doc had removed his helmet and had lowered his hood. In the darkness of the cabin, the lights of his suit glowed like a childhood fantasy. Motes of dust swirled from his red cape and caught in his long white beard like flakes of fresh-fallen snow.

"Mer-r-r-r-ry Christmas!" he bellowed again, and gave another jolly laugh.

In that instant, he was no longer Doc Spanjaard. He had become every holiday legend. Sinterklass, St. Nicholas, Father Christmas . . .

"Santa!"

The little girl I had heard earlier bolted from the gloom. Before Kyle or Marcie or anyone else could grab her, she rushed across the dark cabin.

"It's Santa Claus!" she screamed. "Santa's on Mars! Mama, you were right! There's a Santa Claus on Mars!"

As Doc bent to catch her in his arms, I heard another child call out, then another, and suddenly two more kids darted past the legs of the bewildered adults surrounding us. They were all over Doc before anyone could stop them, least of all Kyle, who suddenly didn't seem to know what to do with the gun in his hands, and Doc was laughing so hard that I thought he was going to loose his balance and fall back into the airlock with three children on top of him, and everyone else was yelling in relieved surprise . . .

Then Marcie turned to Kyle, who stood in gape-jawed confusion, his blaster now half-raised toward the ceiling so that it wasn't pointed at any of the kids.

"So what are you going to do?" she murmured. "Be the guy who shot Santa Claus?"

He stared at Doc, then at me. "But it isn't Christmas yet."

"Welcome to Mars," I said quietly. "We do things a little different here."

He nodded, then put the gun away.

And that was our Christmas miracle.

We dispensed some food from the lander; the three children were handed toys from Doc's sack and the adults were given two bottles of wine. Doc spent a couple of hours treating injuries while I went back to the rover and radioed both Thankgod and Arsia to tell them that we had located the lander. Arsia informed me that the storm was ebbing in our region and that DaVinci had already volunteered to send out a couple of rovers to pick up the new arrivals. I relayed the news to Kyle, whom I learned was their leader; he couldn't look me straight in the eye when he tendered an apology for his behavior, but I accepted it anyway.

By the time Doc and I left the crash site, the first light of dawn was appearing on the eastern horizon; it might be

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midsummer back on Earth, but here it was the third sol of Christmas. Peace on Mars, good will towards men.

We completed that long, hard tour, and returned to Arsia Station only a little later than usual. Once I had put *Miss Thuvia* to bed, Doc and I decompressed in the Mars Hotel. For the first time since we had started this little homecoming ritual, we allowed ourselves to get drunk. No wonder Doc rarely got blotto; he didn't hold his liquor very well. He sang dirty songs and made jokes no one understood; it's a good thing no children were present, because he would have ruined Christmas for them forever. The last I saw of him that night, he was being helped out of the bar by two of his girlfriends, neither of whom seemed likely to let him quietly pass out before they gave him the mistletoe treatment.

We made eight more Christmas tours before I retired from service. By then I was married and running AeroMars; my wife and business partners didn't want me leaving Arsia Station for several sols each year to haul candy and toys to distant settlements. Nor was it necessary for me to play Black Peter any longer; now there were nineteen self-sustaining colonies scattered across the planet, and nearly every one of them had their own homemade Sinterklass and Zwarte Piet costumes.

Doc, though, continued to play his role every year, if only to take a rover out to nearby settlements. He was the first and best Sinterklass on Mars, and everyone wanted to see him. He relished the job, and continued it longer after he set up a private practice at Arsia. Toys and candy for all the children, wine for the adults, and a different Zwarte Piet everywhere he went. It was what he did, period. And whenever he came home, we got together for drinks and small talk.

Twelve years after we made the Acidalia rescue mission, though, Doc didn't come back to the bar. He went out alone to Ascension during another dust storm and . . . well, vanished. No final transmissions, and no one ever found his vehicle. He simply disappeared, just like that.

I miss Doc, but I think this is an appropriate way to go. Mars is full of mystery; so is Christmas, or at least it should be. The holiday got ruined on Earth because everything wonderful about it was gradually eroded, the magic sucked away. Out here, though, we've got a great Christmas, and a patron saint all our own.

He lives in the caldera of Olympus Mons. ■

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DeepDrive, Alexander Jablokov, Avon, $14, 311 pp. (ISBN: 0-380-97636-6).

Lethal Exposure, Kevin J. Anderson and Doug Beason, Ace, $5.99, 290 pp. (ISBN: 0-441-00550-0).

Accidental Creatures, Anne Harris, TOR, $22.95, 287 pp. (ISBN: 0-312-86538-4).

Brown Girl in the Ring, Nalo Hopkinson, Warner, $12.99, 250 pp. (ISBN: 0-446-67433-8).

Mockingbird, Sean Stewart, Ace, $21.95, 279 pp. (ISBN: 0-441-00547-0).

Inhuman Beings, Jerry Jay Carroll, Ace, $12, 249 pp. (ISBN: 0-441-00529-2).

Swords Against the Shadowland, Robin Wayne Bailey, White Wolf, $9.99, 207 pp. (ISBN: 1-56504-893-8).

Alien Life: The Search for Extraterrestrials and Beyond, Barry Parker, Plenum, $27.95, 254 + x pp. (ISBN: 0-306-45795-4).

Alexander Jablokov was involved in the Future Boston project, in which a group of Boston-area science fiction writers imagined that a variety of aliens appear and settle in, much as did immigrants from all over Earth in the past, and thereby change the flavor of the city, making of it a strange and wondrous place indeed.

In **DeepDrive**, Jablokov gives us a broader take on the same basic idea. Aliens—eleven species—have at long last come to the Solar System. There are Gunners on Mercury, firing packages of isotopes into the sun, Bgarth on Venus, tunneling like giant earthworms (does "Bgarth" come from "Big-earthworms"?) through and remaking the crust, Ulyani on Earth, their sapient embryos the centers of powerful clans until they hatch and go on about their business. Their technologies are strange, wondrous, largely biological (even spaceships are grown), and highly coveted by mere humans.

Especially coveted are the deepdrives that powered the ships on which the aliens arrived. Humans are desperately eager to get their hands on a working deepdrive and escape the home system for the wonders of the stars. But the aliens appear unwilling to permit such an escape. Their deepdrives have always self-destructed promptly on arrival, quite as if human explorers of a cannibal island burned their boats when they hit the beach.

Holed up on Venus is Ripi-Arana-Hoc, the sole representative of the Vronnan species in the System. He is sharing secrets with and protected by the Venusian government. Does he know how to build a deepdrive? No one knows, but he has managed to get out word that he would like a little help escaping from Venus. The tech-hunters are on their way.

Meet Soph, Kun, Kammer, and their team, arriving above Venus only to find that the *Argent* is ahead of them, and its captain, the misshapen Tiber, has vanished on the planet below. Ripi has not yet been extracted, and if they are fortunate, Soph *et al.* may yet succeed in their mission. But only Soph survives the

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landing. Soon she is teamed with Tiber, Ambryn—who uses alien anatomies to foretell the future—and Elward, a thug and enforcer who will soon no longer be a limo driver.

Ripi is soon in orbit, but the adventure has only begun. There are mysteries here, serendipitous interconnections among seemingly unrelated events and characters, forces in play that no one more than dimly suspects until far too late, and finally a revelation of the nature of the deepdrive and a great deal more besides.

As usual, Jablokov delivers a very satisfying product. The man is very good indeed. This time too, there is a little extra for the SF fan, for his conclusion says in effect that the route to the stars lies within each of us. The sense of wonder that marks the SF sensibility is hard to teach and certainly cannot be dictated or overlain on a soul that lacks it. It must come from within, and when it does, all the wonders of the universe are within reach.

Enjoy.

Once again, Kevin J. Anderson and Doug Beason bring *Analog* readers a mystery right up their alley. **Lethal Exposure**'s venue is the Fermi National Accelerator Laboratory (Fermilab) in Illinois, where the buffalo roam the restored patch of prairie surrounded by the accelerator ring, senior scientists drool for the Nobel Prize, and Ukrainian refugee physicist Georg Dumenco is trying to prove his theory of how to increase the production of anti-protons enough to fill a trap which, when full, would hold the explosive equivalent of a small nuclear bomb.

You can already guess what goes wrong, can't you? Anderson and Beason don't make the details explicit right away, but Dumenco is working on his experiment when the beam line glitches, there is the sound of a distant explosion, and he gets a massive dose of radiation. So massive that he will be dead in a week.

Accident? Or murder? That explosion vaporized a small concrete building. There's no trace of explosive. Radiation specialist Trish ("call me Patrice") LeCroix calls her old boyfriend, FBI Special Agent Craig Kreident, to invite him in on the case, and he's on his way, really quite keen on a murder whose victim is still alive to help him out.

Very soon, the reader meets Dumenco's naive and unimaginative grad student, who is stealing anti-protons to sell to an Indian political party's "medical" research project (as I wrap up this column, the news is full of India's nuclear "device" tests). An FBI agent gets shot. There are hints that Dumenco's prerefugee research had considerable military significance. Someone trashes Dumenco's apartment and tries to kill him in his hospital room. Kreident and his partner get gassed.

This one spends less time on the minutia of Big Lab Tour than did the first Kreident novel (*Virtual Destruction*, reviewed here in August 1996) and more on investigation. I found it therefore more absorbing, a very good read, a genuine pleasure.

Anne Harris's **Accidental Creatures** is a very readable novel with a frustratingly large flaw. On the positive side, she gives us a nice portrait of a world dominated by heartless corporations that exploit their workers and plot to replace them with technology. The corporation is GeneSys. It grows sheets of living biopolymers in great vats, and it employs vatdivers to put on sealed suits, swim through the brew of forming polymer and remove unwanted lumps and fibers. Unfortunately, the biopolymer growth medium is exceedingly toxic to living flesh, the company is not too concerned about safety and worker protection, and when the workers organize to protest, the lead agitator, Ada Chichelski, dies in an apparent drug-induced screw-up in a vat.

Now meet Helix. She's an orphan

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taken in by hotshot genetic engineer Dr. Hector Martin, who protects her against the slings and arrows of all the ordinary folk outraged by her fangs and extra arms. Encouraged by a mysterious figure on the 'Net, she runs away, gets mugged, and is taken in by Chango Chichelski, sister of the late Ada. Before long it becomes very clear that Helix is driven to become a vatdiver, and when she gets her chance, she takes off her suit and swims bare, reveling in the toxic growth medium. The vatdivers quite reasonably see in her a threat to their jobs, and the reader nods, for there have been enough hints to make it clear that Helix is a genetically engineered device designed in fact to replace the divers. Indeed, her engineer was Hector Martin, and he screwed up from the corporate point of view: he didn't make just a tool; he made a *smart* tool, one quite capable of competing on equal footing with humanity.

Helix is also a person thoroughly deserving of the reader's sympathy. Harris has done an excellent job of making her real, and it is very easy to read and enjoy the story. Unfortunately, there is the negative side. For one thing, filter screens would surely do just as efficient a job of removing lumps and fibers from the vats as human divers, without the attendant problems of labor relations and potential contamination of the medium. The novel's great flaw is the artificiality of its essential situation; it's a too-obvious setup, which makes it difficult to suspend disbelief enough to enjoy it as we might have if that situation were more likely.

Awhile back, Warner Aspect announced a writing contest for first novels. Over a thousand entries came in from all over the world, and in July 1997, the winner was selected by C. J. Cherryh and announced as Nalo Hopkinson. Her entry, **Brown Girl in the Ring**, is now available, and it justifies the contest effort, establishes her as a writer to watch, and says something about *your* chances, Bubba, in the infamous slushpile.

Brown Girl is Caribbean magic realism set in a Toronto abandoned by twenty-first-century society. Everyone with money has moved to the 'burbs. There are roadblocks to keep the poor from following. City government has been replaced by the posse, a variant Mafia ruled by the evil Rudy.

Canada is ruled by Premier Uttley, a scheming woman whose heart is failing. Normal procedure would be to replace it with a heart from the Porcine Organ Harvest Program—pigs are bred for just this purpose—but she's been slipping in the polls. Better to craft a pitch to the animal rights folks—those poor little exploited piggies!—and say she will accept nothing less than a real human heart, a donation of the old sort, people helping people.

Trouble is, nobody's volunteering. So the call goes out—find a heart, any heart, as long as it's healthy and human. And here's a representative of Angel of Mercy transplant hospital talking to Rudy, naming the price, defining the scruples in play.

Now meet Ti-Jeanne, newly a mother, gifted with sight, living with her grandmother, Mami Gros-Jeanne, who serves the down and out of future Toronto as a healer and voudoun priestess. Ti-Jeanne's ex-boyfriend, father of her babe, is tapped to hunt down the heart—he tries to escape both task and city, and the gods come down to ride Mami, Ti-Jeanne, the babe, and all. The evil at the city's heart, you see, has much to do with the old ways; Ti-Jeanne's family is deeply involved in it all; and it is up to her to put an end to it even if she is barely more than a babe herself.

This one's good—a compelling read with a number of characters one is happy to have met. It justifies the contest. It honors the Clarion tradition (Hopkinson is a Clarion grad). But to be quite honest, I doubt that it will live forever unless

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Hopkinson goes on to write more novels and develop a following on that basis. The book may be one in a thousand, but the 999 others were not published novels—most were essentially slushpile slush. This is a background against which it is much easier to stand out; at the same time, Bubba, it reveals how much labor editors must go through to filter *your* masterwork from the pile of paper sent in by other hopefuls. After all, even the worst of the slush must be examined long enough to identify it as such. That may mean only a few minutes, but when those minutes must be multiplied by a thousand—over and over again—well, perhaps we shouldn't cuss so much.

Sean Stewart is one of those daring male writers who can write from a female point of view and make it work—at least as far as this male can tell. His **Mockingbird** is Texas magic realism, gritty and real and spooky, that should appeal to fantasy fans and mainstream readers alike.

Here's the setup: Meet the Beauchamp (BEECH-um) family. Momma is a strange old bird with a cabinet full of gods—the Widow and the Preacher, Sugar and Pierrot, Mr. Copper and the Little Lost Girl, and the titular Mockingbird—which at times occupy Momma's head, make her do strange things, and give her a gift of prophecy that has stood her in very good stead as advisor to an investment firm. Alas, Momma has died, and life goes on. Daddy remains, background stability. Daughter Candy is the pretty one with a busy social life and the ability to see the nice things in the future. Daughter Toni is an auditor, good job, money in the bank, life on tracks, until Candy offers her a tot of something Momma left behind just for Toni. It's Mockingbird cordial, and as soon as Toni sips, Momma's gods invade her skull. She loses her job. She has herself artificially inseminated and looks unsuccessfully for a husband. She utters a curse and watches it come true. She tries to sell off Momma's cabinet full of gods and finds that they won't let her. She hunts desperately for a way to get back on the tracks.

And in the end, she learns something of the human need to open ourselves up to the various aspects of ourselves that help us cope with life. This one's not a thriller. It has no strange planets or aliens, no dragons or spells, no wizards or elves. But it is a very satisfying tale, very well told. I enjoyed it.

Jerry Jay Carroll's **Inhuman Beings** finally gives us a way to tell who the *real* psychics are. Life has turned deep dark brown for private eye Goodwin Armstrong—divorce has put him in the poorhouse and a new computerized investigations outfit is underpricing him out of business—when Princess Dulay shows up in his office. She's a psychic, and she *knows* that aliens have arrived in the form of a black bowling ball. She also knows they want to take over the Earth, and she wants Armstrong to tell the President.

Reeaallyy? Well, when she starts waving a sizable check, Armstrong decides he might as well give it a shot. And then important people start turning up dead. So do psychics. The tenement hotel in which Armstrong is staying bursts into flames, and the neighbors report seeing simultaneous blue flashes in all the rooms. A blue Taurus follows him. Security cameras pan to watch his every move. Princess Dulay's bank accounts turn up empty. People and animals change their behavior as if they have been taken over by . . .

Clearly, something funny is going on. In fact, aliens is the best explanation Armstrong can come up with. So he starts a one-man war, the bodies start piling up, and . . . Well, we think from the start that he didn't win, for the tale begins in "The Hole," solitary confinement, where Armstrong is stupefied by drugs in his food. He thinks the aliens won

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and captured him, though he doesn't know why they didn't just take over his mind. Surely it's only a matter of time. Meanwhile try not to eat, try not to drink, and while the thoughts remain clear, remember . . .

Carroll does a nice job without shattering any paradigms. The tale moves right along, it holds the interest, and Hollywood could surely have fun with it. The biggest flaw is the end, when victory comes far too easily for a foe that has been built up to be so powerful. But that is a very traditional flaw; "the unbeatable human species" practically defines a subgenre of SF—indeed, it was once very common in this magazine—but that subgenre has long been marked less by human supercompetence than by suddenly revealed alien blind spots.

Of considerable interest to fans of the late Fritz Leiber and that famous duo, Fafhrd and the Gray Mouser, is Robin Wayne Bailey's **Swords Against the Shadowland**.

It seems that before Leiber died in 1992, he and Bailey were planning a series of collaborations to bring Fafhrd and the Mouser back into play. Alas, it fell to Bailey to do the job alone, and a very creditable job he did.

The time of the tale is shortly after the heroes lost their true loves in Lankhmar. They had set forth in anguish to live by banditry, and now they are fleeing through the Mountains of the Elder Ones with the contents of Lord Hristo's strongroom. As they rest, they dream of a jealous wizard, Malygris, and a malevolent spell that slew his foe with a terrible wasting disease. When they waken, they are far from their ill-gotten treasure, and a mysterious wizard—the infamous Sheelba—in a chicken-legged hut is telling them that a spell is out of control, slaying all who have ever been touched by or used magic, including—cough! cough!—himself. Yet he *can* defeat it if a certain pair of rogues will catch Malygris and extract a drop of his heart's blood.

And off they go to face the shades of their lost loves, to find tragedy and pain, love and sacrifice, on the way to fulfilling their quest. It is clear that the magical plague is AIDS, and the tale's point is poignantly expressed in Bailey's last words, "If only all man's plagues could be such a neatly ended fantasy."

If you have no taste for allegory, don't worry. The tale is entirely satisfactory without the AIDS interpretation. Bailey is not Leiber, and his story doesn't quite read the way Leiber might have written it, but it's not far off at all, and never in any way that warrants criticism. Bailey has done a fine job. Fafhrd and the Gray Mouser live again, as their originator cannot.

If you wonder how new tales can be fitted into the canon, this is the hitherto untold first encounter with Sheelba, and Sheelba is a powerful wizard who is quite capable of creating cracks in Leiber's ficton more than capable of holding a new novel or two.

Barry Parker's **Alien Life: The Search for Extraterrestrials and Beyond** is a breezy survey of exobiology from the Urey-Miller work (nearly 50 years ago) on how life might easily have originated from simple chemistry through the Drake equation and searches for intelligent radio signals, Martian meteorites, Europan seas, extrasolar planets, and more. The target audience is not the typical *Analog* reader, for Parker devotes a fair amount of attention to discussing UFOs, alien abductions, and even von Daniken's fictions (which seem quite quaintly dated today), using relatively respectful tones even when he is dismissive.

This is a good one to urge upon your local town and school libraries.

Anadems

According to a recent *Wall Street Journal* item, some 62 million US citizens (out of a total of 265 million) now use the Internet. A quarter of them were

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new to the Net in 1997. 43% have a college degree or higher, and their average salary is $55,000, more than twice the US average of $25,000.

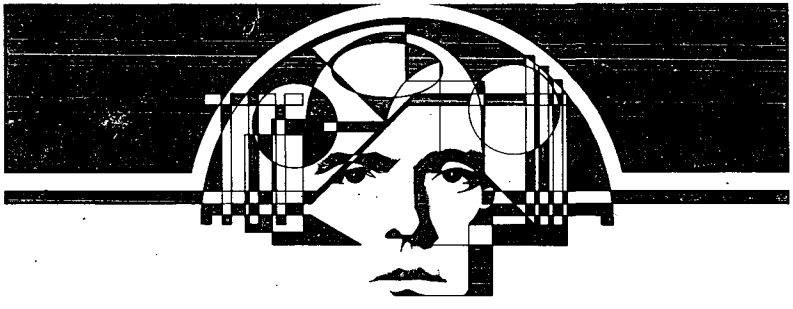
It's therefore not at all suprising that a great deal of effort is going into figuring out how to make on-line publishing a success. One of the leaders in the effort is Ken Jenks, whose Mind's Eye Fiction (http://tale.com/) has been offering short fiction, much of it reprints from magazines such as *Analog*, on a unique basis: read the first half of the story free, but if you want to see how it ends, pony up another fifty cents or so. That works out to about what you would pay per story in *Analog* or a paperback anthology, so it really isn't a bad deal, and you can get such familiar authors as David Brin, Harlan Ellison, Larry Niven, Spider Robinson, Fred Saberhagen, Bud Sparhawk, Ian Randal Strock, Lawrence Watt-Evans, and Bud Webster, among others.

Now Jenks is starting to do novels. The first is my **Unto the Last Generation**, a tale of quest for recovery from eco-collapse and shattered civilization (some of the characters are gravestones containing downloaded minds). The price for a download is just $3—that's where paperbacks were fifteen years ago—and if you own a PalmPilot, you can read the novel in the form of a Cyberbook much as Ben Bova envisioned a decade ago.

What's a PalmPilot? That's a $200-400 (depending on model) hand-held computer whose face is almost all screen. Pitched as "The connected organizer," it stores memos, contact information, schedules, reports, etc., does e-mail, and can update its contents by linking to the Internet (see http://www.palm.com). Jenks wants users to buy fiction through the same linking process.

And yes, as it happens, there are things in my novel that look a lot like PalmPilots. I even added suitable labels after this deal was set up.

Check it out. ■



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We will soon be co-hosting chats with The Sci-Fi Channel. Don't miss their Third Annual Online SF Convention (SCIFI.CON3.0) October 30–November 1. For more Information, go to **www.scifi.com/scifi.con**. Look for the *Asimov's* panel "Working in Other Media: Translating Fiction to Film" with Michael Cassutt, Melinda Snodgrass, Gardner Dozois, and others.

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BRASS TACKS

Dear *Analog*,

I've been an *Analog* reader since I discovered its unique blend of Science Fiction/Fact in the late fifties. Been hooked ever since. This month you gave me two nice surprises. The first was the new-size *Analog*—I remember back to the large size issues also—it has a nice feel to it and I'm looking forward to more of your good work in each issue. The second is your web page. I'm not sure if I just have not seen it or if it is indeed brand new. In any case it's new to me. I'll be dropping by from time to time to see what you have on the Internet. Keep up the good work, it's appreciated. Thanks for everything!

DAVE TIMME

Dear *Analog*,

What? Changing the mag's size again? You young whippersnappers obviously don't know or care about the mag's own history and are, thus, doomed to repeat the mistakes of the past. *Astounding* went to a larger format some years ago with disasterous (sic) results. About all that was accomplished was to screw up everyone's shelf space and storage boxes. After a couple of years, saner heads prevailed and you returned to the old format. Come on! Give us a break and leave well enough alone.

JACK PAGE
7107 Buckingham Dr.
Germantown, TN 38138

I suspect we're far more familiar with the magazine's past history than any reader who hasn't worked here could be. The new experiment may not do everything we hope it will, but we have reason to believe it might—and we did not make the decision lightly. So far a large majority of reader comment on the change has been positive, for such very good reasons as a substantial increase in what you, the readers, get for your money.

As for screwing up shelf space, a word of friendly advice to anyone collecting a long run of any *magazine: hardly any magazine keeps exactly the same format forever. (This one has changed several times.) Shelves can be made adjustable, and there's a lot to be said for building them that way!*

Dear Stan,

Just wanted to let you know how much I enjoyed most of the June issue. "Clunky" and "Corkscrew," "Difference" and "Bug" all blew me away. "Spindown" did not work for me. I did not even finish it. But the excellence of the others more than made up for this. I've not yet gotten to the third part of "Children" though I've enjoyed the first two parts. Last month's "The Human Touch" and "Yellow and Orange Blues" were most enjoyable. I like stories where the sleaze-bag bureaucrats get their karma and where different creatures are shown not to be a threat.

The science fact section is usually most enlightening, though on a few occasions it's a bit hard for me to follow.

I do very much like the new size.

I also wanted to thank you for something that did not appear in *Analog*. I'm now on the mailing list of the seminar.

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It's something I hope to participate in on line soon and someday, when I can afford the six hundred bucks, to participate in person. Damn good story. *(Editor's note: This refers to the Asimov Seminar and the story "Good Intentions" by Jack McDevitt and Stanley Schmidt, in the June 1998* Fantasy and Science Fiction.*)*

BOB FRIEDMAN

Greetings!

As usual, I found your editorial interesting and thought-provoking. Basic research is one of the building blocks of science and/or technology. However, most people go for the research that is both funded and approved by their peer group. First, they have to live and second they have to publish.

What I perceived to be the theme of your editorial reminded me of the series of articles that Dr. Asimov wrote in *The Magazine of Fantasy & Science Fiction* in the seventies and eighties. Each month he had a different subject and in almost every column he had references to work that was either carried out by "amateurs" or those who were not considered part of the "scientific establishment" (my words) of the time. Some of his articles on science and the results of experiments were published as collections that are well worth reading: *The Relativity of Wrong*, Pinnacle, 1988; and *Asimov on Astronomy*, Doubleday Anchor, 1975.

Carry on the good work.

C. HENRY DEPEW
Tallahassee, FL

Dear *Analog*,

Dr. Schmidt's editorial in the June 1998 issue was an admirable description of what research is *really* all about. It is easy to set "objectives," but things have a way of happening by chance, luck (both good and bad) and serendipity. Somebody (I can't recall who, if I ever knew) said, a long time ago: "If we knew what we were going to find, it wouldn't be research." Present-day administrators would do well to remember that.

CHARLES H. CHANDLER
Lexington, MA

Analog:

Paul Levinson's article, "The Book on the Book," in the June issue of *Analog*, was thought-provoking. It gave a good view of the likely future of books.

But some other points can be made about information in electronic form. The main advantage he cites is that it makes it easy to look up references to other texts. That is important, all right, but how many people do what amounts to research? How many more people just read for entertainment? For them, the most useful function of having reading matter on screen instead of on paper is not links to other documents, but the ability to search within the document they are reading. For instance, reading a story or an article in *Analog*, I've wondered about something I'd already read in it. "I thought this character was introduced before that." "Doesn't this contradict the point he made earlier?" It's downright annoying to have to look back through the text. "Maybe it's not at the top of a left-hand page like I thought it was." But if it was in electronic form, all I'd have to do is use the search function, and there it would be. It's the same for people who read mystery stories, or history texts, or even mathematical treatises.

How did we ever get along with just paper?

J.A. COFFEEN
Houston TX

Dear Dr. Schmidt,

I was reading Dr. Paul Levinson's "The Book on the Book" on the Metro this morning when I thought of two more points in favor of the printed page over the computer.

The first is, of course, portability. Laptop computers are all very well and

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good, but you can't read one standing up on a train and holding on with one hand! Likewise, with a book, you don't have to worry about the battery going dead just when you get to the good part. I realize that these problems will probably be solved eventually, but I'm not so sure about the second difference.

There was a report on one of our local news stations about a month ago regarding "Computer Eye Syndrome," a form of eyestrain that arises from spending too long reading a computer screen. Part of the problem, according to the report, comes from the brightness of the screen itself, but the larger part comes from the difference between the way letters appear on a printed page and the way they are generated on screen. Printed letters (unless the printer messed up) come out as sharp, smooth lines.

Letters on a computer screen, being made up of dots, tend to be blurrier. The eye is therefore unable to bring it into proper focus, so it keeps adjusting and readjusting itself, leading to tired eyes and headaches.

That, at least was the theory from the news report. I know from personal experience that my eyes hurt a lot more after a day of working at my computer than after a similar amount of time working with printed or written pages.

I have a feeling that books will survive just fine alongside computers!

AMY E. BAGGOTT
7623 Matera St. #104
Falls Church, VA 22043

Dear Dr. Schmidt,

I found "The Book on the Book: A Prognosis for the Page in the Digital Age" to be interesting but lacking in several vital facts that will affect whether the book survives in the digital age. Perhaps as the retired director of the Library Division of The Library of Virginia I am biased, but during my time with The Library, I was intimately involved in similar discussions. The following are points that were relevant, and not always answered:

1. While copy on demand is a feasible alternative, it still raises a vital point of how it would be monitored in order for the author to be paid a royalty for his/her work. This is also true for on-line access to a work. While current access to the Internet allows for the use of credit cards, it also allows anyone to post their own web page, and therefore the posting of one's favorite reading. If attention is not paid to this, authors (especially of fiction with sci-fi included), may be leery of writing for an on-line publisher.

2. Currently there is a very large audience for what in the library world is referred to as readers of Harlequin Romances. This group wants light fiction, almost throwaway, that is produced in bulk and very cheaply. Since a large proportion of these readers have not had computer training, and unless their children have a computer, will not spend the money for one for themselves, there will be strong resistance to a computer book.

3. It seems to be an axiom that all worthwhile books and periodicals will be converted to a digital format. I would challenge this concept. At the library of Virginia alone there are over 1.3 million items in the library collection and more than twenty million items in the archives collection. Dealing strictly with the Library collection, these items range from a manuscript book dated 1380, to multiple volumes of periodicals, to individual books, to pamphlets, broadsides, photographs (extensive Virginia collection), paintings (the official Virginia collection) maps, and other items. In working with the Library of Congress on their American Memory project and the American Newspaper project, it was accepted that the average size of an item in a collection was two hundred pages. It was also accepted that the average cost to scan, monitor and enter into a computer file was two dollars per page. This was allowing for the fact that it is a manual operation (some books would be too fragile to be handled by machine,

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and not necessarily the oldest ones) and standards had to be maintained. Using these figures it can be seen that the economics of the operation are almost prohibitive. I have seen it argued that many library holdings overlap those of other libraries. Having supervised that automation of the Library of Virginia, and been closely involved in the cataloging of materials into the OCLC national database, I can affirm that the holdings of the Library of Virginia show less than forty percent overlap, and this is probably true for many large research libraries.

4. While Dr. Levinson does deal with the problems of changing technology, it is not in a detailed fashion. The National Archives, at a meeting that I attended, were concerned with the drive for digitizing because they maintained that technology completely changes every ten years, and therefore the entering would have to be redone every ten years. It is a common rumor, which I have never bothered to verify, that the 1960 U. S. census can be read on only two computers, one of which is in Japan, and that the 1970 census can no longer be read on any computer.

5. Finally, a recurring concern was the question of who would maintain the huge database of non-current materials, and where it would be maintained. There are serious questions being asked as to whether all the universities who have already produced online periodicals are maintaining their earlier records. I accept the fact that we are able to store more in less space than ever before, but this is still an enormous amount that must be kept accessible. A corollary to that is the growing concern that some people think all information is now on the Internet and forget how little is actually there.

This is not meant to be a refutation of Dr. Levinson and his ideas, which, as I said, I found very interesting, but an outline of some of the more serious problems that I feel face us as we move into the future.

My fifteen-year old daughter commented that the ability to sit on her dad's lap and be read to, while looking at pages and pictures, and to jump back and forth to different pictures would not be the same with a computer, but I reminded her that I helped teach her words and meanings with a simple crossword program on our computer. I do feel that we are moving to more information available online, but foresee the book lasting usefully for a long time.

BILL CHAMBERLAIN
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Glen Allen, VA 23060
wchamberlain@erols.com

Dear Dr. Schmidt,

The new format is a definite winner.

With the good news out of the way, I must comment on "The GUAC Bug." The basic story line is good solid science fiction, but the political dig at drug companies takes a long hike into fantasy. Assuming that Gruen is successful in developing his miracle cure virus, someone is still going to need to build and operate the manufacturing plant. Someone will have to develop the protocols for operation of the plant, down to the cleaning materials used on the floors and the soap in the rest rooms. Someone will have to develop manufacturing, distribution, storage and final delivery protocols. Someone will have to prove to the Food and Drug Administration that these protocols are correct and that the resulting product is both safe and effective. Someone will have to carry massive amounts of product liability insurance to protect the drug company from the person who develops toenail fungus after being cured of the fatal disease.

All of these buildings, protocols, research, development, insurance, attorneys, etc. must be paid for! These costs are paid out of gross profits. In the real world, the research to develop the next miracle cure must also be paid out of

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today's gross profits on the current cures. The "Bis" cure will still cost twenty billion dollars a year and some people will not be able to afford it. That is reality.

CARL E. HICKMAN
105103.2020@compuserve.com

The author replies. . . .

Mr. Hickman is absolutely right. A plant to make a new drug takes everything he mentions, and more. And now that Gruen has thrown Bis into the public domain, let's hope C-T will go ahead with their plans. They may eventually encounter some competition, but that's the name of the game.

CHARLES L. HARNESS
110400.1232@compuserve.com

Stan—

Reading the June issue, I had a thought. Triggered by the lead short story, Wolf Read's "Spindown," which postulates humans with extreme longevity . . . supposedly having been around for millions and millions of years. OK, it's been done before, but this time I found my disbelief impossible to suspend.

Perhaps I'm getting curmudgeonly as I age, but I notice my own developments—each year I think a bit differently, and see things in a slightly new light. Here are these characters, after millions of years, and they still talk "baby talk." Contemporary concepts, words, feelings . . . haven't they learned *anything*?

I don't intend to flame Mr. Read; he is by no means the only offender in this regard. Obviously, any story must be "accessible" to today's readers. This puts some limits on the futuristic dialog. I do remember Olaf Stapledon's "Last and First Men," wherein the narration conveyed the sense of change and evolution—mostly by avoiding direct dialog, also by explicit acknowledgment—from time to time, of the non-translatable motives and concepts of our far-future descendants.

We do not readily grasp large numbers, or their implications. We can *say* "millyuns and millyuns," but we really don't understand those magnitudes. The newspapers today frequently interchange "millions" and "billions" when talking dollars. The average reader understands that is a large number, which may be all that's needed . . . or may not.

In your editorial, "Interesting Research," there's one facet you ignore. Yes, by all means, let the researchers follow their inclinations . . . if they are good enough. In fact, isn't that pretty much how the Bell Labs works? . . . or worked? I'm unsure what the outfit is doing these days, but thirty years ago or thereabout I recall they were inclined to pick top people and give them a free rein. But if you don't have the top people, just "journeymen," perhaps the notion that they should have some direction into "useful" avenues isn't totally bad.

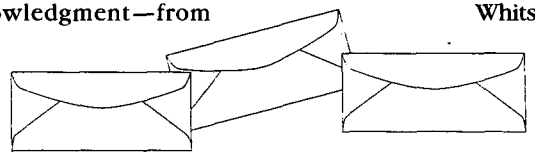
WAYNE RAYLE

Dear *Analog*,

I just finished Amy Bechtel's "Yellow and Orange Blues" (which I greatly enjoyed, along with the previous stories in the series), and then saw the facing page . . .

Please pass my condolences on to Mr. Stine's family. I guess that I unknowingly knew more of him through his work, for longer than I'd previously thought, growing up building plenty of model rockets and watching the space program. And reading him for I don't know how long . . . We will all miss him greatly. As a tribute to what he gave to all of us, we must endeavor to carry on his legacy.

JERROLD E. GLUCK
Whitstone, NY ■



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UPCOMING EVENTS Anthony Lewis

27-29 November 1998
CONCAT 10 (Knoxville area SF conference) at Radisson Summit Hill, Knoxville, TN. Guests of Honor—Jaenne & Spider Robinson; Artist Guest of Honor—Darryl Elliot; Special Guest of Honor—Rick Shelley. Registration—$25 until 10 November, $35 at the door (limit of 500). Info—Concat 10, c/o Chloie; (423) 637-6564 or (423) 523-6986. e-mail—chloie@aol.com; URL—http://www.members.aol.com/knoxsf/cradle/concat.html

27-29 November 1998
LOSCON 25 (Los Angeles area SF conference) at Burbank Airport Hilton, Burbank, CA. Guest of Honor— David Brin; Artis Guest of Honor—Sue Dawe; Fan Guest of Honor—Marjii Ellers. Registration—$35 until 31 October 1998, $40 thereafter. Info—LosCon, c/o LASFS 11513 Burbank Blvd., North Hollywood, CA 91601. URL—http:www.lasfs.org/loscon25/

4-6 December 1998
POLECON MCMXCVII (High Arctic regional SF conference) at the Workshop, Nunavut. Guest of Honor—TBA; Artist Guest of Honor—John Frost; Fan Guest of Honor—Gojira. Registration—Invitational con; free memberships will be sent to good girls and boys (we know who you are. . .).

2-6 September 1999
AUSSIECON THREE (57th World Science Fiction Convention) at World Congress Centre, Melbourne, Australia. Guests of Honor—George Turner (in memoriam), Gregory Benford, Bruce Gillespie. Registration—$155 (A$200); supporting $35 (A$45). [These are the latest posted rates as of the time this column went to press. Rates will go up mid-August 1998 and then again 1 January 1999.] This is the SF universe's annual get-together. Profesionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competion—the works. Info—Aussicon Three, GPO Box 1212K, Melbourne VIC 3001, Australia. US Agent—PO Box 266, Prospect Heights, IL 60070-0266. URL—http://www.aussiecon3.worldcon.org ■

Convention runners: If your convention has a telephone, fax, e-mail, or web page URL, please let us know so that we can publish this information.

Convention attendees: When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an IRC if the convention is in a different country.

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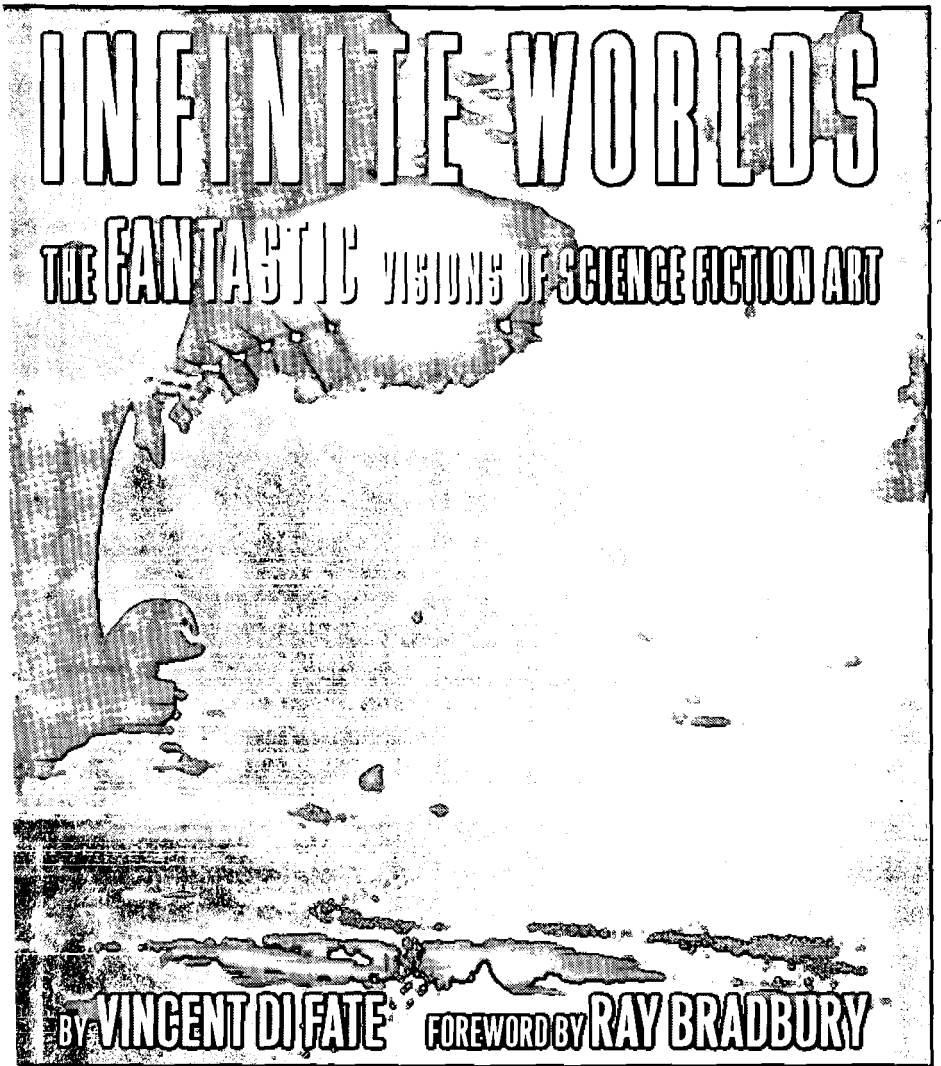

From movie posters to book covers, from raging raptors to video villains, here is the definitive collection of science fiction art. Artist Vincent di Fate has compiled nearly 700 images from the worlds of science fiction literature, television, and film to represent 150 years of graphic imagination, including work by Frank Frazettta, Michael Whelan, Leo and Diane Dillon, and many others. With its dazzling four-color illustrations and fascinating text, *Infinite Worlds* is a treasure every art and science fiction devotee will want to own.

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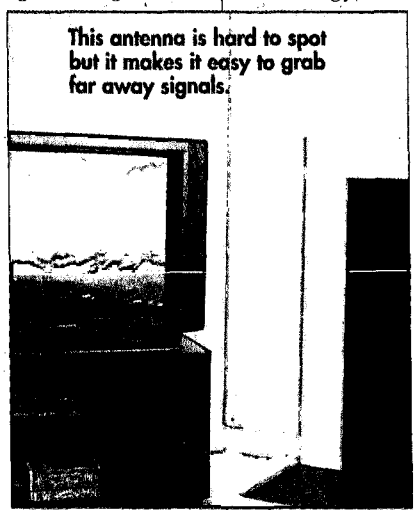

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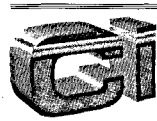

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